THE

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NIAGARA FALLS ELECTRICITY WORKS.

PROF. FORBES has laid before the Institution of Electrical Engineers some details of electrical machinery to be used in generating, transmitting, and transforming, the electrical energy to be produced by the Niagara Falls.

The power at the Falls is very large, and is never likely to be entirely used. The portion of it now being utilised is of considerable magnitude compared with other water-power plants, so that the progress of the scheme is naturally looked upon with much interest by engineers in general and electrical engineers in particular.

The Cataract Construction Company, who have the water rights, and who are laying down the plant, some years ago consulted Prof. Forbes and other eminent engineers and electricians as to the best system for the distribution of the immense power at their disposal. Hydraulic transmission, compressed air transmission, and all other proposals were rejected in favour of electricity as the transmitting and distributing agent.

Having decided upon using electrical distribution, the next question was to decide upon the system to adopt. The continuous current, the alternating current, and the multiphase current systems were put before the Cataract Construction Company by the various manufacturers and others interested in them. The continuous current was obviously unsuited to deal with long distance transmission of large powers, for the high pressure generators and the transforming introduce insurmountable difficulties. The single-phase, or common alternating current, would be quite capable of dealing with the transmission to any distances, and there is no difficulty with extra high pressure generators, nor in transforming up or down, but as the Niagara scheme is principally for power purposes, the single-phase system, looked at from the distribution of power point of view, presented some doubtful aspects. Single-phase alternating motors of the synchronous type are simple, effective, and highly efficient motors, but they require to be started without load; single-phase commutatorless non-synchronous motors are stated to work as well as synchronous motors, but like the synchronous, they will not start with a load on. Another objection to the adoption of the single-phase alternating current arose when considering the supply of continuous current, for although continuous current is of no special use for transmitting and distributing electrical energy, it is of great value for working arc lamps, for electrolytical and electro-metallurgical purposes, and as the reduction of aluminium and copper is to be worked on a large scale from the Niagara power, it was necessary to consider the supply of continuous current as one of the cardinal points of the scheme.

Considering all things, the only system which offered a complete solution of the problem was the multiphase system. Two multiphase systems were available, the

two-phase and the three-phase. The three-phase system presents some difficulty in regulating the three currents, principally because the three currents must necessarily be inter-connected, and it has no advantages over the two-phase. On the other hand the two-phase currents are easy to regulate, the two currents being independent; hence it was finally decided to adopt the two-phase alternating current system, with two independent currents in quadrature phase.

So far good; but when we come to consider the reasons advanced for the adoption of the machinery which is being laid down, they do not seem altogether so satisfactory. We refer to the electrical plant.

The Cataract Construction Company, we are informed in Prof. Forbes's paper, had many beautiful designs for generators submitted to them by experienced electricians in different parts of the world, and one of the reasons given for the rejection of European plans seems to us peculiar, namely, "the high tariff and freight charges on European machinery" made the cost prohibitive. This is a frivolous excuse; the high tariff and freight were perfectly well-known objections before European designers were invited to send in designs. European designers would naturally conclude that no such objections would be raised to the acceptance of their tenders. American designs were rejected for other reasons—reasons with which we can safely leave the Americans to deal.

Finally, the Cataract Construction Company accepted the designs of Prof. Forbes for the generators, and the contract for their construction made with the Westinghouse Company; that is, they accepted the designs of their own adviser and consulting engineer.

As for the design itself, we may say that there is no difficulty whatever in designing and constructing two-phase generators; there is really no perceptible difference between a two-phase and a single-phase alternator. We have no reason to suppose the generators will not come up to their designer's expectations; but judging from the drawings exhibited, we are afraid the curve of the rise and fall of pressure at the terminals will not even approach the form of the favourite sine curve.

The coils are of oblong rectangular shape, with narrow sides, so that a steady pressure will be generated for a considerable time at the maximum rise and fall, giving a curve which has been irreverently called a top-hat curve. This form is due to the wide coil. As its narrow sides sweep across the broad face of the pole pieces, the number of magnetic lines threaded into or out of the coil regularly increases or decreases, not at an increasing or decreasing *rate*, but at a constant *rate*; hence during that time the pressure generated will be constant, not rising or falling as in a sine curve. A flat curve such as these machines may be expected to give is all very good for lighting purposes, and for rectifying purposes direct, but a flat curve in a primary circuit produces a very bad form of secondary current in a transformer, and is not good for two-phase or multiphase motors. The form of the secondary current curve produced by this so-called top-hat primary current might, to use a name from a similar object, be called a clown's-hat curve, like the following .

The dynamos are to be used with step-up transformers to raise the pressure, so that they are comparatively low pressure machines. Why they were not made of 100 or 150 volts, nor why they should be designed for 2,500 volts when step-up transformers are used, is not explained. We are of opinion that the plan of circulating oil through the armature coils will never be seriously entertained by electrical engineers. Judging from the supports shown for the shaft carrying the huge overhanging umbrella-like field magnets, it would not be surprising if these dynamos vibrated considerably when running loaded.

The next point of interest is the low frequency of 25 periods per second. The arguments advanced in favour of low frequency are convincing enough, but they do not clearly settle what is the best low frequency, considering all things. Practice on the Continent of Europe has fixed 42 as the low frequency. Theory in the Cataract Construction Company has defined 25, and upon frequency depends a great deal the success or failure of the schemes using two-phase currents. We believe, on the whole, the lower limit is the best upon theoretical considerations, but practice alone can finally decide such a question.

The chief objection in practice to low frequency is the greatly increased cost of transformers. Another objection is that lamps cannot be worked direct upon low frequency circuits. That, however, is not a very serious objection; in a large distribution scheme lamps would be worked indirectly.

Prof. Forbes's paper is rather obscure on the motor question. He says a good deal about synchronising motors, but did not enlighten his hearers as to how these motors are to be started either with or without a load. No doubt at low frequency a simple motor can be made out of any continuous current motor by placing two contact rings on the commutator, but even then there is the difficulty of starting.

The two-phase motors will be selected, no doubt, as there are no difficulties whatever about them.

We anticipate the chief troubles with the motors will arise on the patents questions; synchronising motors are not patentable; but devices for starting them are good patents, so that inventors of these devices must be reckoned with, and there are many claimants for improvements in two-phase motors, so that the difficulties will not be so much in the way of working them as in the acquiring of motors on reasonable terms.

The great question as to how the continuous currents are to be derived from the two-phase currents is very inadequately treated in the paper; we all have a dim notion of the turning of the two-phase into continuous currents by the dynamos made by Schückert, and that method is to be employed at present by the Cataract Construction Company It is, however, one which is very little known, and has not been tried on any extensive scale. The action of these machines has been investigated, but nothing has been yet published regarding their theory of action.

This method of converting two-phase into continuous current at Niagara will be awaited with considerable interest by electricians. This dynamo motor plan of converting two-phase into continuous current does not promise to be the best; it is far too cumbrous, and is not of the highest efficiency, besides which, heavy sparking at high outputs is inevitable.

The Professor referred to commutator methods as being possible, and expressed his opinion that they would be forthcoming. We have already heard of successful com-

mutator methods, such as Pollak's for single-phase currents, and of others, not yet made public, for two-phase currents.

The meagreness of the details given regarding the vital points of the scheme can be perfectly well understood. Although a few workers here, and on the continent, in the two-phase currents have discovered a great deal, and could furnish much information, the time has not yet arrived when it would be of any interest to do so. Of what avail would it be to put a commutating piece on the market for two-phase currents, or to put a two-phase motor on the market? None whatever; there are no two-phase currents at present to commutate, and no two-phase currents to drive the motor. In the meanwhile the Cataract Construction Company will be practically in the hands of the speculative companies who control the patents for two-phase apparatus in America.

With the completion of the Niagara Falls scheme of transmission, the distribution questions will come to the front, and no doubt any demands arising for motors and commutators will be met in the natural manner after such demands arise.

On the whole question regarding the two-phase system, the litigation likely to arise out of the use of patented apparatus is the most serious trouble to be anticipated; not that we consider the claims made as right and just, in fact, many of them are absurd, but however far wrong such claims may be, they have to be dealt with at considerable expense and trouble. And hence we are afraid the introduction of this system will be hampered by such actions to no small extent.

In all other respects we congratulate the Cataract Construction Company on their choice of a system. We look forward to many valuable and lasting advances being made after it is established, for placing a two-phase current at the disposal of the consumers and the public in active places in America, will enable their properties to be studied, and applications to new purposes will soon be suggested.

Notes on Gutta-Percha.

IT is good news to the electrical trades as well as to the inhabitants of Madagascar, that a new gutta-percha tree has been discovered in that island. Last year competent experts recognised this gutta in the districts of Farafangana, Vangaindrano, Manaimbondro, Fort Dauphin, Andrahomby, and Cape St. Mary; and an apparently well-informed correspondent of the *Journal des Mines*, now states that the discovery has been already so well exploited that trade in Madagascar is receiving a welcome stimulus. At first the gutta realised from from 3 to 6 piastres per 100 lbs.; aided by competition the price very soon rose to 15 piastres; and now upwards of 20 piastres per 100 lbs. is paid for the raw product at Fort Dauphin. It is to be hoped, with such eloquent object lessons before them as can be drawn from the past commercial history of gutta, that the Malagasys will turn their immediate attention not only to extracting the gum, but to cultivating and preserving the tree. As an illustration of the intelligent carefulness which may now be employed to prevent the waste even of a grain of the gum we may notice a new process invented by Mons. Sérullas for the purpose of extracting it from any part of the tree. The dried and pulverised parts are digested in a vessel provided with a steam-jacket and agitator, the solvent being toluene. All the gutta-percha passes into solution. The solution is then run into a still in which the toluene is evaporated off and recovered for subsequent operations; the dry gutta-percha being then ready for manufacture. By this means every twig and leaf of the tree can be made to yield up the whole of the gum contained.

A Study of Electric Oscillations.

THE study of the electric oscillations first recognised by Lord Kelvin and Von Helmholtz, is becoming of greater importance every day, and, thanks to the experimental work of Hertz and others, we appear to be rapidly approaching a more rational explanation of the phenomena of light and electricity. Tesla's work carries our knowledge of these phenomena forward with a bound, and when we consider how many experimentalists are engaged in the same researches, not only in this country but abroad (*e.g.*, Fiddersen, Blasema, Bernstein, Schiller, Mouton, &c.), there appears every reason for sanguine expectations that we are on the eve of great discoveries. The August number of the *Journal de Physique* contains a valuable contribution to our knowledge of this subject, from Mons. Janet, who describes his experiments on oscillations of about $\frac{1}{10000}$th second duration. Mouton's modified interruptor was chiefly used, but new methods of examination were worked out, amongst them one for the determination of the coefficient of self-induction. The paper is illustrated with curves, which Mons. Janet believes to represent the actual forms of the curves of intensity and electromotive force. Several side issues were studied in this research, amongst them the hysteresis and dielectric viscosity of mica. He concludes that in a condenser with solid dielectrics, under the influence of rapid electrical oscillations, there is a "lagging" of the charges behind the differences of potential, that is to say for equal differences of potential the charges are smaller with increasing than with decreasing potentials.

Electrical Waves.

AMONGST recent researches on the wave phenomena of electricity may be noticed those of V. Bjerknes in the *Annalen der Physik und Chemie* (Vol. xlviii., pp. 592—605) and Birkeland in the *Comptes Rendus* (Vol. cxvi., pp. 803—806). The former finds the extinction power of metals for electrical waves to increase with good conductors, and that it also increases with the magnetism of the conductor. The more rapid the rate of the waves, the less distance do they penetrate into the body of the conductor. Bjerknes calls attention to certain discrepancies between the electro-magnetic theory of light and the ordinary theory, and he states his opinion that electrical waves represent the motion of molecules as a whole, whilst ordinary light waves are concerned with the motion of individual molecules. He makes the pregnant suggestion that a study of the action of very quick electrical oscillations on magnetic molecules may serve to determine a limit to the inertia ratio of an iron molecule. Wave phenomena are approached from another standpoint by Birkeland who points out the applicability of Poynting's theories to the explanation of the resonance phenomena discovered by Hertz. He submits the theorem that the electro-magnetic energy in the field surrounding the conductor moves in space in a direction normal to the lines of electric force and magnetic force at each point. He then discusses this theorem, and shows that it leads to an explanation of multiple resonance, and the various discrepancies between theory and experiment noticed by those who have experimentally investigated and studied the phenomena of Hertz.

THE SCIENTIFIC STUDY OF ARC LAMPS.

By RANKIN KENNEDY.

III.

THE friction brake or clutch acting on the smooth rod is our next study. A great many lamps use this mechanical device; it is very old in arc lamp work, being first patented in 1854 by Messrs. Slater & Watson. It is the mechanical device in the Brush lamps, and in the Thomson-Houston, and many other American lamps, and was used in the original Brockie lamps.

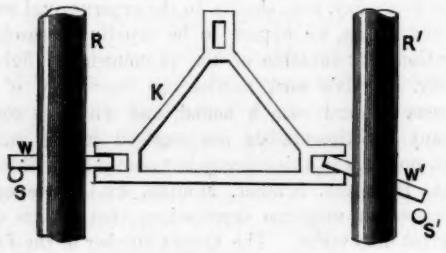
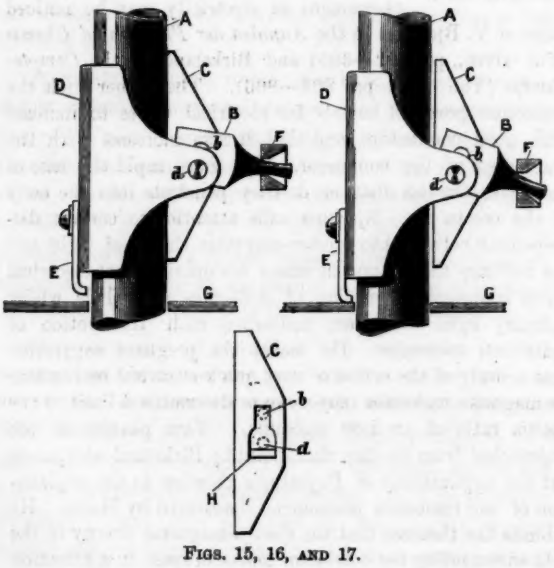


FIG. 14.

Fig. 14 is the Brush original clutch, two of them are here shown working in a double lamp; R, R', are the carbon holder rods, and W, W', two brass washers slipping easily over them. The frame, K, can be raised and lowered, thus canting up the washers, and so gripping the rod as seen in the right hand side of the figure. The other washer is seen square with the rod in this position. It allows the rod to slip through; thus, by raising or lowering the frame, K, the rods may be gripped and lifted up or lowered until the washer comes down upon stop, S, when it will be released and allow the rods to move down and so feed the carbons together. It will be obvious that by making one of the stops a little higher than the other, that the washer on that side is released first, so that the rod, R, is fed down first before rod, R', and thereby the carbon on rod, R, is consumed before the carbon on rod, R'. When the carbon on rod, R, is finished, a stop on rod, R, prevents it from slipping further through; the frame, K, is then lowered until rod, R', is released and fed down.

Figs. 15, 16, and 17, illustrate the improved brush clutch.



FIGS. 15, 16, AND 17.

It will be observed that a brake block, C, is worked by a lever and pin. The thin washer previously used was apt to stick into any irregularities in the rods; the long saddle and brake block works much more smoothly. On lifting at F, F, the block grips and the rods are raised; on lowering at F, F, one of the fingers, E, E, comes down on the plate, G, and on further lowering, the block is released and the lamp fed; the one rod is fed before the other by making the one finger, E touch the plate, G, before the other touches.

One other form of clutch, a modification of Slater and Watson's, of 40 years ago, makes a very simple and effective feeding mechanism. Mechanics and students often desire to make a simple arc lamp—they cannot do better than adopt this mechanism—it is simple, easily made, and effective. For that purpose, when I come to the complete lamp descriptions, I shall give a scale drawing of this lamp. Fig. 18 shows the general arrangement; the carbons work over a

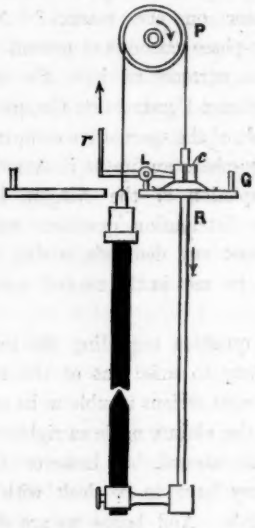
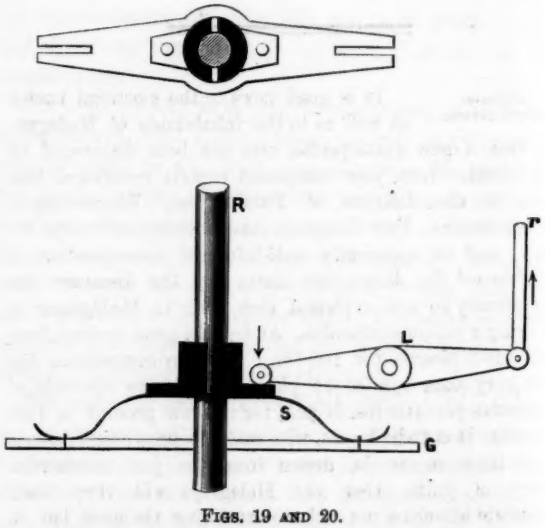


FIG. 18.

pulley, P, on a flexible chain or cord, the clutch, c, on rod, R, is a split tube fixed on a flat spring resting on plate, G. The lever, L, is worked by rod, r, and on lifting r, the lever depresses the clutch, causing it to grip the rod by closing in the two halves of the clutch and bending the spring, thus forming the arc. On lowering rod, r, the spring rises and opens the clutch to let the rod feed through. Fig. 19, shows the flat spring and split tube clutch in plan, and fig. 20, an elevation of the mechanism; the spring, S, is



FIGS. 19 AND 20.

made of hard brass if durability is of no consequence, but tempered steel springs are preferable.

There are many other modifications of the clutch and rod, but these examples are quite sufficient for our purpose.

We have now examined the three chief devices in the mechanism of arc lamps: the "screw;" the "wheel gear and brake;" and the "rod and clutch." Upon these devices,

lamps can be built to do any kind of electric lighting, and to meet every requirement. All that is required to make a successful lamp is, first, good mechanical design and good workmanship. Mechanical accuracy is one of the first requirements; this can be secured only by the use of machinery to reproduce the parts, and workmen accustomed to the use of accurate tools.

There are several nondescript lamps in which little or no mechanism is connected with the feeding mechanism; as a rule, such lamps are only suitable for special purposes.

A famous lamp, in which there is no mechanism connected with the feeding device, is the lamp of Piette and Krizik, known as the Pilsen lamp; then there is the Jablochkoff candle and the lamp Soleil or sun lamp, using incandescent marble, a lamp about which we shall find a good deal of interest when we come to consider it as a whole. These three lamps we shall consider in our next article.

STATISTICAL NOTES ON THE ELECTRIC LAUNCHES AT THE WORLD'S FAIR.*

BY R. N. CHAMBERLAIN.

THE readers of this and other electrical journals have before been made acquainted with the general design, construction, and electrical operation of the 54 electric launches operated by the Electric Launch and Navigation Company, on the lagoons of the World's Fair.

Believing that a concise statement of the actual work and operating cost of these launches will be of deep interest to the electrical fraternity, since the launches are operated under novel and severe conditions, the writer presents the following data which are computed from records carefully kept from the beginning of this unique business enterprise.

APRIL 13TH TO OCTOBER 1ST, 1893.

Mileage and Passenger Traffic.

Passenger trips of three miles each	47,787
World's Fair special launch trips	6,750
Special trips of regular launches	1,220
Trial trips	270
Experimental trips	180
Total number of trips	56,207
At three miles per trip, total miles	168,621
Average miles per launch to October 1st	3,122
The total number of days the 54 electric launches have been in service on the lagoons of the World's Fair, is	6,594
Therefore the general average of miles per launch per day, is	25·57
Minimum miles, per launch, per day	14
Maximum " " "	37½
Maximum miles, one launch, one day	54
Total number of passengers carried from May 1st to October 1st	801,000
Maximum passengers carried in one day by one launch	464
Maximum number of people carried by one launch for one round trip	40

Operating Cost.

Average cost per launch, per day, for charging, at 3 cents per electric horse-power	55½c.
Average cost per launch, per day, for care and repair of shafting, propellers, 54 motors, 162 packing boxes, 3,524 storage batteries, including labour for charging, 54 controllers—all the above being gone over every 24 hours	43c.
Renewals of batteries per launch, per day	41c.
Renewals and repair material for all else, per launch, per day	9c.
Total cost per launch, per day	$1.48½
Average cost per launch mile for labour and material, exclusive of office expenses	5½c.

When it is understood that already the launches have run on an average, four times the number of miles a launch owned by a private individual would ordinarily cover during a regular season, and that, as all who have been connected with this glorious Fair will vouch for, the operating expenses are decidedly heavier than under ordinary circumstances, it will be acknowledged that the cost per launch mile is exceedingly low. Judging from the experience of six months with the 54 launches the writer believes the expense can, and will be, in the near future, brought down to as low a figure as three cents per electric launch mile where at least 30 launches are operated under like conditions—less World's Fair extra expenses. Though the electric launches have carried over 801,000 passengers, not a single accident has occurred, and it was exceedingly rare that a boat had to be towed in, except through injury to the propeller or shaft by the floating and sunken débris in the lagoons of the World's Fair.

At some future date the writer may give a list of the difficulties encountered in maintaining and operating electric launches on a practical scale and what methods are pursued to obviate them. As all know, every system, whether electric lighting, electric railway, or electric launches, all develop their own peculiar "bugs" which those in control seek to banish at the earliest opportunity.

To the designers of the launch, Gardner & Mosher, to the Consolidated Electric Storage Company, who supplied the storage batteries, to the General Electric Company who furnished the specially designed motor, and particularly to the intelligent and industrious work upon the part of the *employés* under the skilful management of the officials of the company, is due the entire success of this, to very many, doubtful enterprise.

* New York *Electrical Engineer*.

A MODIFICATION OF MAXWELL'S ELECTRICAL THEORY.

LAST year we noticed a modification of Maxwell's electrical theory developed by Alex. McAulay, M.A., University of Tasmania. The principal object of the paper in which this was discussed was to free Maxwell's theory from certain difficulties which the author experienced in applying it to gross matter, but he was careful to point out at the beginning that the theory which he proceeded to develop might require serious modification for the aether. In a paper contributed to the *Philosophical Magazine* for August, 1893, he briefly considers what modifications, if any, are required.

Much of this paper is occupied with the mathematics of the various questions which McAulay considers, and these will be found of great interest by those who have the knowledge and the time requisite for following him through his analyses; they cannot be usefully condensed; indeed, the whole paper is very much compressed and would be more enjoyable were it of a more elaborate character.

McAulay argues that Maxwell has not shown his right to ignore, as he does in considering the propagation of waves, the equation of motion of the medium. It is not hard to show that we may disregard it if we accept his equations as literally true for rapid waves in a medium of ordinary density. But we may do so for the aether, and may we do so in the case of gases, he asks, where the gross matter present has practically no effect on electrical actions?

By ignoring the equation, Maxwell is led to the conclusion that the aether, when it is excited by electro-magnetic waves, exerts a pressure on gross matter. What then, he says, is the effect of this pressure after it has left the sun and before it has again reached gross matter? It must have some effect on the aether, but he points out that the equations expressing that effect are wanting. If we tie ourselves down to a strict dynamical theory these equations appear, and we have to decide what is their meaning.

A case is stated, and an equation given, which is expressed by saying that the "Poynting intensity" remains constant for every element of the aether. It follows also that there is no ponderomotive action and reaction between the aether and gross matter, which has an obvious bearing on the question of whether or not the aether can exert a pressure on gross matter.

McAulay then asks the pertinent question: Are these results consistent with an electro-magnetic theory of light? He thinks they are not, but this is not on account of the most obvious apparent consequences; and he instances the

fact of the constancy of the "Poynting intensity." From this he deduces that if any part of the aether were ever electrically at rest, the actual displacement and magnetic force for that part would always be parallel, and if the displacement and magnetic force were for any part of the aether ever not parallel, that part could never come electrically to rest.

These results are not *necessarily* inconsistent with the theory of light, for it must be remembered that the aether now contemplated is capable of indefinite expansion or condensation, and that whatever be the amount of this expansion or condensation, its electrical constants remain absolutely unaffected. But, by indefinite expansion the volume distribution of "Poynting intensity" is indefinitely diminished, and conversely for condensation. In fact the aether is capable of moving, and in case of forced irregular disturbance would move with velocities comparable with that of light. This explains how Mc Aulay can on the present hypothesis account for the encroachment with sufficient rapidity of light waves on a previously dark region.

Difficulties are, however, candidly admitted and discussed, and we may yet see a third paper in modification of this, the second, which, as we have said, is itself a modification of the first in which these views were propounded. As it stands, this work opens out a new avenue for mathematical investigations, the exploration of which we think is likely to be very fruitful.

THE NEW SYSTEM OF ALTERNATING CURRENT AND TRANSFORMER DISTRIBUTION.

By RANKIN KENNEDY.

III.

THE typical generator, shown in fig. 1 in our last article, would be quite suitable for the purpose but for the low frequency which we could get out of it at moderate speeds; at a speed of 1,200 any two-pole machine would give us a frequency of 20 periods per second only. Now, this frequency is far too low for general purposes; first, because it would require very large transformers to deal with such a frequency—transformers are smaller the higher the frequency—secondly, the current waves at this frequency are quite perceptible on any lamps fed by the currents; these are fatal objections to low frequency for general purposes. Low frequency has some advantages for motor purposes at the present moment, and mainly for that reason a frequency as low as 25 per second has been adopted for the two-phase currents to be used at Niagara Falls; here, however, the system is intended for power alone, not for a general distribution scheme.

We are studying a universal system for all purposes to which an electric current may be required in a city or town, and in this system the frequency must be high enough to avoid the two difficulties above-mentioned with transformers and lamps. Experience with quadrature currents has convinced the author that the frequency must not be less than 60 to 64 per second.

We shall adopt 60 as our frequency. Now, a two-pole generator would require a speed of 3,600 per minute to give this frequency, that is a speed far too high for ordinary driving; we must therefore adopt a multipolar dynamo for the generator; the frequency per revolution is equal to the number of pairs of poles, so that the revolutions per second multiplied by the number of pairs of poles equals the frequency; it might be an 8-pole Mordey Victoria compound dynamo, or an 8-pole Kapp compound or shunt dynamo, such as is used at the Regent's Park Station in London; collecting rings would require to be fitted to the shaft, and connections made to the commutators for the collection of the quadrature currents. With these dynamos we would get a period of four per revolution of the armature; hence $\frac{60}{4} = 15$ per second would require to be the speed, that is, 900 per minute. If we doubled the number of poles the speed would be halved=450 for the same frequency. For slow speed direct coupled to engine dynamos, 450 is high enough; hence about eight pairs of poles would be the lowest number allowed, if the dynamo was of the ordinary build of continuous current dynamo, with multipolar field driven direct coupled.

While such dynamos would be perfectly practicable, and would perform well, yet it is found desirable to simplify the design for the purpose of the new system, and, finally, a design is arrived at which meets the requirements fully. In this machine the field magnet can be made in two castings of cast-iron or steel, and only one coil is required to excite all the poles, however numerous; in fact, it is a modification of the Kennedy ironclad dynamo, first exhibited at Edinburgh Exhibition in 1886. All the poles on one side are the same, say N. All the S. poles are on the other side of the coil of the magnet, and these poles are "staggered," that is, the poles on one side come opposite the spaces between the poles on the other side. So far this was the original design of the magnets, and it is so still in the new machine. In the new machine the armature is a drum armature, wound as a multipolar series wave, or loop, with end connections. In the old ironclad the armature was a disc wind and cross connected in series on the Ayrton & Perry plan.

The armature, W, fig. 2, consists of a broad rimmed cast-

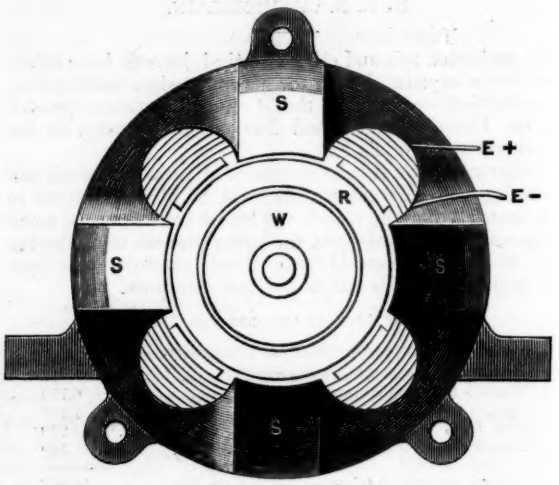


FIG. 2.

steel pulley, turned true all over, so that it is balanced. On the outer periphery deep rings of thin sheet-iron, R, fig. 2, form the laminated surface next to the poles. The path of

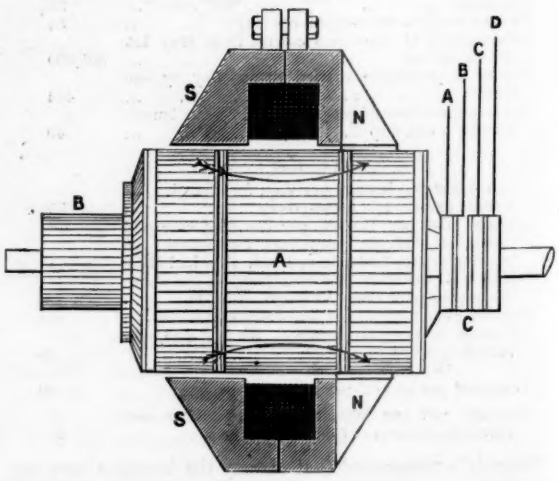


Fig. 3.

the magnetic flow is not concentric with the armature but parallel with its length, as shown by arrows in fig. 3; in this it differs from all other drum armatures.

The machine, fig. 4, gives a general notion of the external appearance; it is of an exceedingly simple design, and very cheap to manufacture in large sizes.

At the commutator end, B (see fig. 3), the continuous currents are collected if required, and the exciting current for the magnet is taken from B. At the collecting ring end, C, the two quadrature currents are collected from the four collecting rings, A, B, C, D.

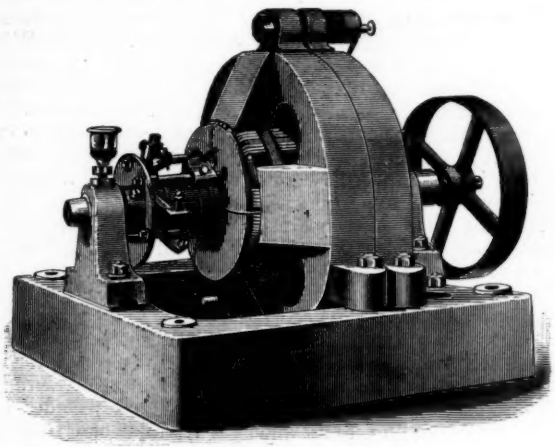


FIG. 4.

Fig. 3 is a view of the armature *in situ* with the field magnets in section, the exciting coil being shown in the recess. The arrows show the path of the lines of magnetic flow. These magnetic lines enter the armature radially through the laminations, R, see fig. 2, then flow axially, and emerge again radially through the laminations. The axial flow is principally, if not wholly, through the rim of the pulley, and is a steady flow and therefore sets up no eddy currents; the radial flow is the varying flow, therefore it is designed to take place in the laminations.

With such a disposition of poles and winding, the disturbing effects or distorting effects of the armature current on the field is reduced to a very small amount. But the great advantages of this design are, the extreme simplicity, the great mechanical rigidity and compactness, and the enormous output from a comparatively small amount of material. In practice the best armature for the purpose has the laminations slotted for the armature wires, so that these wires are safely embedded. The field strength can be made of immense power, as the magnetic circuit is short.

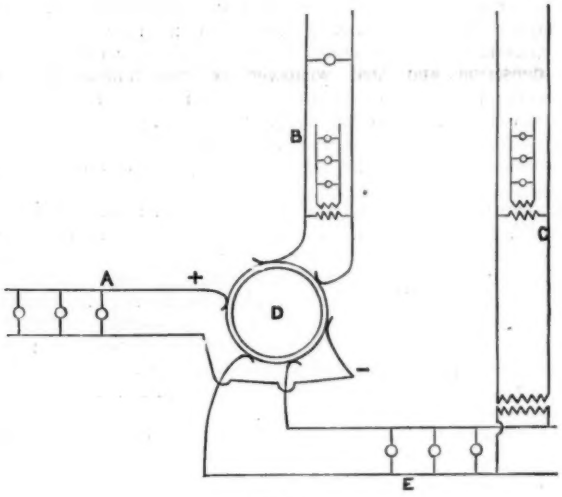


FIG. 6.

Fig. 5 is Schückert's quadrature and continuous generator. It consists of the Schückert ordinary 8-polar continuous current dynamo, with four collecting rings outside the front bearing, connected through the hollow shaft to four points, 90 degrees apart, on the commutator. This machine requires a speed of 900 per minute to give a frequency of 60 per second, it has 16 coils to excite the field, and has intricate cross connections in the armature. It is, however, a highly finished, well designed machine, and was shown at Frankfort Exhibition working perfectly on this new system. The machines described in this article are suitable for use in generating stations in towns, cities, and districts, where the currents are to be supplied for all purposes, and it will now be clear that any generating station fitted with such machines is prepared to supply either or all of the different kinds of current required. From the ordinary continuous

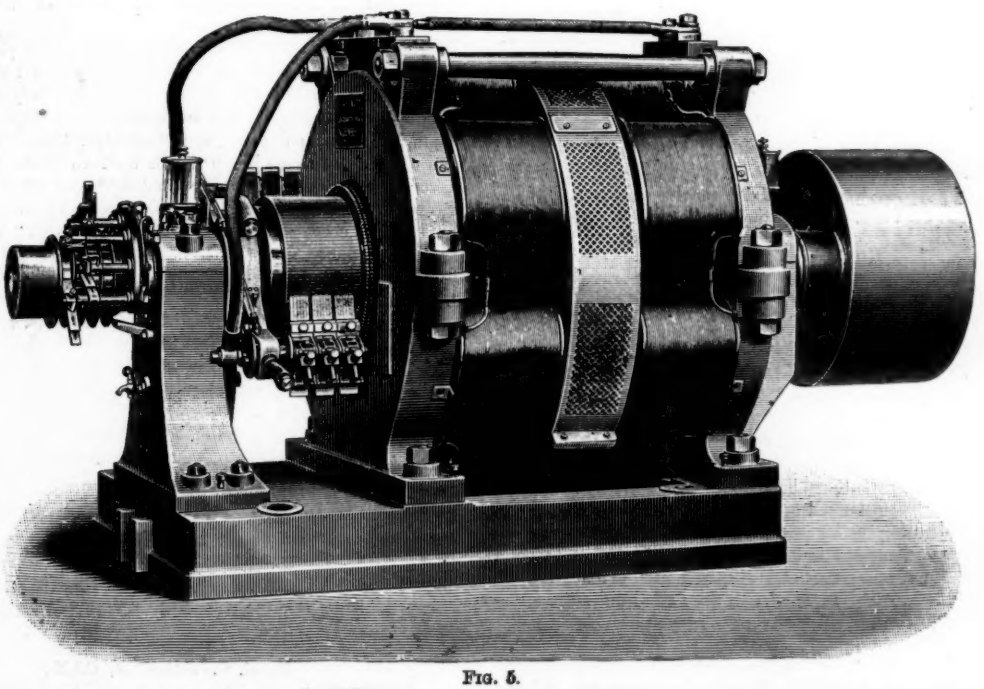


FIG. 5.

current commutator the ordinary continuous current can be sent out, while from the collecting rings, A, B, C, D, fig. 3, or those outside the bearing in Schückert's machine, a single phase ordinary alternating current can be sent out, and also the two-phase quadrature current.

Fig. 6 is a diagram of a dynamo of this kind. A is the continuous current, B one of the alternating circuits, and E the other alternating circuit, while C represents a high pressure alternating circuit derived from E. It will be quite clear that there is nothing requiring electric current that could not be supplied by such generators. The engineer to whose heart the continuous current is hugged close, and who has a horror of alternating currents, can have all the continuous current he wants, while the alternating current disciple can have it anyhow he wishes, high or low pressure, single, or two-phase.

There is no conceivable reason why such machines should not always be put down for central station work. The question as to whether a corporation or supply company should adopt "the continuous current system," or the "alternating current system," should never more be heard. Any supply system which cannot supply any kind of current demanded is merely a childish attempt at electrical distribution; and now that it is perfectly plain how to supply any kind of current from ordinary dynamos, there can be no excuse whatever for persisting in these attempts.

These machines can also be used for distributing light and power on steamships and in mines, using the quadrature currents to drive motors having no brushes and no commutators, and therefore requiring no attention.

The continuous current P.D. at terminals is fixed at present at 120 volts; but if incandescent lamps can be got of a higher voltage, as no doubt they can be very soon, then a higher voltage is preferable.

The alternating current can be raised to any desired pressure by step-up transformers for long distance transmission.

Now, for some purposes, a dynamo for high pressure work is desirable, so that no step-up transformers are required. A pressure of from 10,000 to 30,000 volts is required for long distance transmission of power by quadrature currents.

Prof. Forbes's high pressure quadrature dynamo will probably be described fully in other articles. It is a special machine for very high pressure and very low frequency, made to meet the case in hand at Niagara.

For our purpose we must look at the question from a general point of view. We want a machine which can be handled safely, and kept running in such out of the way places as use waterfalls for the motive power, and transmit the power to a distance.

With very low frequency the step-up transformer would be a difficulty, it would be very large and costly, hence in the case of low frequency transmission it has been considered cheaper to build the machine for high pressure and save the cost of the step-up transformer.

The author prefers the use of the low pressure dynamos as herein described, and to use a frequency not less than 60, so that step-up transformers can be used for the high pressure circuits without any serious additional cost or losses.

We shall find a very important difference in quadrature dynamos in respect to the method of working the circuits, the dynamos for continuous and alternating currents have both alternating currents connected through the armature. In dynamos, like alternators, the currents and circuits are independent and unconnected.

(To be continued.)

A NEW PRINCIPLE IN THE SEPARATION OF METALS.

MUCH difference of opinion has hitherto existed on the questions whether the decomposition of an electrolyte first occurs when a given voltage is used, or whether it begins at a voltage lower than that normal to its accomplishment under ordinary conditions; and wherever opinions are widely separated it may often be profitable to pass them in review or to sift those which are based upon experimental evidence from those which are more empirical, or, to use a term that is creeping into use amongst scientists as well as politicians, are chauvinistic. H. Freudenberg has been endeavouring to reduce these conflicting opinions, on the period at which electrolytic dissociation is initiated, to something like order, in a paper recently published in the *Berichte*, Vol. xxv., p. 2,492, and has found the process so suggestive that he now states what will be regarded as a new principle in the electrolytic separation of the metals.

The hypothesis that the decomposition of an electrolyte commences at a voltage lower than that normal to its accomplishment under ordinary conditions is supported by the experimental fact that water is electrolysed by currents of small voltage. In casting about for an explanation of this circumstance, we note that Helmholtz has attributed it to convection currents, whilst Arons has endeavoured to explain it by reference to the different electric charges borne by the ions of which the electrolyte is composed. A natural consequence of this theory is, that its supporters must consider that every electrolyte contains an innumerable multitude of compounds of various degrees of stability, and hence that even the weakest electromotive force is sufficient to set free a certain proportion of ions, or, in other words, to initiate the electrolytic decomposition.

Unfortunately for the supporters of this theory, there is some experimental evidence which cannot be reconciled. Le Blanc, in a paper which may be consulted in the *Zeitschrift für Physikalische Chemie*, 1892, p. 299, has recorded his observation that a definite voltage is essential, and that the decomposition of a given electrolyte cannot be commenced until this condition is realised. There are no experimental results yet published which go to prove that Le Blanc's observation was inaccurate.

Freudenberg accepts Le Blanc's statement as fact, and considering it in conjunction with the well-known fact that metallic salts are electrolysed with great facility, he builds up a method for the electrolytic separation of metals which exhibits quite a new principle.

Almost all the processes which have been proposed, and certainly all that have been successfully and generally used for the electrolytic separation of metals in analysis, have depended upon the behaviour of metallic salts, especially double salts, in various solutions, and upon alterations of the current density. And there is no doubt that in some cases where success has been attained, such success has been due to the variations in voltage which alterations in current density have been accompanied by or have entailed. Freudenberg seizes upon this, and states it as a distinct principle. He does not believe that the convection currents, which Helmholtz suggested, exercise any tangible influence upon the voltage necessary for the separation of metals.

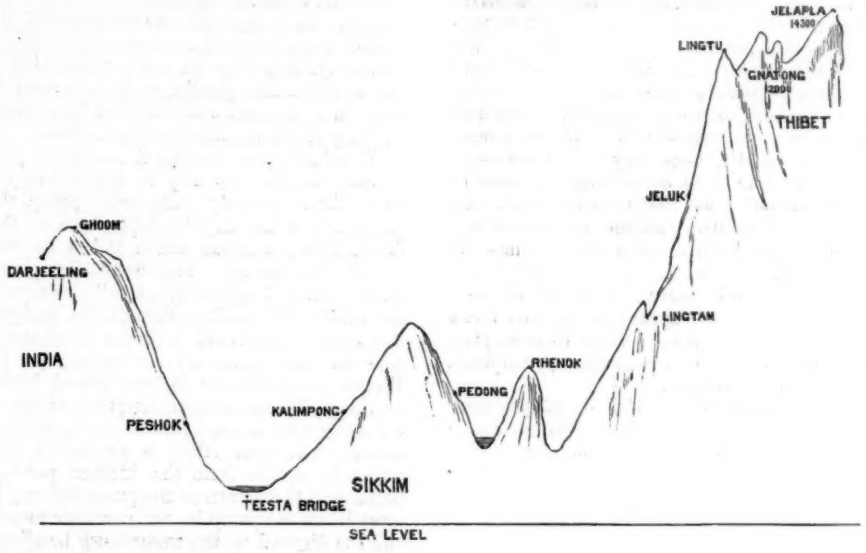
As an illustration of what he now contends for, Freudenberg gives some details of experiments which he has made, *e.g.*, he has succeeded in completely separating silver from copper and bismuth; and mercury, in the mercurous state, from copper, bismuth and arsenic. The metals were dealt with in dilute nitric acid solution, and a Leclanché cell, giving 1·35 volts, was employed. The analytical results which are quoted at the end of this paper appear to be quite satisfactory.

THE TELEGRAPH IN HIGH ALTITUDES.

BY E. O. WALKER, C.I.E.,
Late Superintendent of Telegraphs in India.

THE telegraph line now being constructed from Sirinagar to Gilgit, in Kashmir, will reach an elevation in its route of between 14,000 and 15,000 feet above sea level. It is interesting to recall what was done in Sikkim in the year 1888 in similar altitudes. It had been arranged that a mission to Thibet from India should leave in 1886, to which it is probable that the Thibetans were opposed. In Independent Sikkim, which lies between the Indian frontier and the pass leading to Thibet through the Himalaya Mountains, the Rajah seems to have been instigated to prevent the progress of the mission, and, in the summer of 1888, a British force

marched through Sikkim and defeated the Thibetans who had fortified Lingtu and Jelapla. The telegraph which has, for many years, in India been an indispensable adjunct in warfare, as well for the movements of troops and supplies as for communication with the Government of India, was erected by Mr. W. Hare, Assistant Superintendent of Telegraphs; the task was one of the most difficult that had yet been met with in India, owing to the dense forests and formidable mountains encountered. A small sketch, to exhibit the general contour of the country, taken from a plan by Mr. Luke, C.I.E., Director of Construction in the Indian



Telegraphs, is here given. The horizontal and vertical scales are necessarily not the same; the latter is exaggerated with regard to the former to get the sketch into small space. The line was a temporary one on poles cut in the forest; the wire, 300 lbs. per mile, of iron. An office is still maintained at Gnatong, which is over 12,000 feet in elevation. The difficulty of getting a wire across valleys covered with thick jungle will be readily understood by telegraph men.

Perhaps other readers of the REVIEW may be able to contribute some notes on telegraphs in mountain tracts. Points of interest, upon which information would be useful, relate to the wire used; its size; what precautions should be observed in straining it; how to guard against the great changes in temperature, against snow and avalanches; the equipments of working parties; and the kind of snow shoes found most serviceable for the work.

Until corrected, the Indian Department will take credit for having carried the telegraph to the highest altitude yet achieved, namely at Jelapla in the Himalayas, 14,300 feet.

The account of operations in Kashmir will be awaited with interest. It will not be long before London will receive news from Gilgit in ten minutes. We believe the greatest difficulty experienced is in dealing with the snow.

ELECTROSYNTHESIS.

ALTHOUGH the number of organic compounds that have been subjected to electrolysis is large, certain of the organic acids, together with their salts, remain the only class in regard to whose electrolytic decomposition products generalisations of much interest have been reached. The products obtained on passing the electric current through solutions of other organic compounds have for the most part owed their origin to secondary reactions—generally oxidations or reductions. Such secondary reactions were invariably observed by the early experimenters in this field of research, when the futile attempt was made to confer the property of electrical conductivity on a non-electrolyte, by adding to it a mineral acid or base. Thus it was quickly discovered, for example, that nitro-benzine mixed with weak alkaline or saline solutions is readily reduced by electrolytic hydrogen, and the electrolysis of such a mixture has been patented.

About two years ago S. P. Mulliken began a series of electrosynthetic experiments, which we believe are still in progress, with a view to determining whether certain organic compounds not belonging to the carboxylic acid or salt type, possessing acid properties but not generally recognised as electrolytes, could be electrolysed; and, if so, whether the negative ions liberated from them could be caused to unite with one another by employing methods similar to those used by Crum-Brown and Walker in their interesting synthetic experiments (*vide Liebig's Annalen*, Vol. cclxi., p. 107), and these are the subject of a paper in the *American Chemical Journal*, Vol. xv., No. 6, pp. 523—533.

The group of substances possessing these particular properties is a large and heterogeneous one. They all exhibit exceedingly weak acid properties, and their salts are unstable. Some of them have such low conductivity that even acetic acid, according to the recent molecular conductivity measurements of Walden (*vide Berichte d. Chem. Ges.*, Vol. xxiv., p. 2,025) is, by comparison, an excellent conductor. Mulliken, however, has succeeded, by means of electricity, in synthetically producing a number of compounds, his methods presenting some features of considerable novelty, the application of which may possibly become of industrial importance.

The electrical apparatus used was of the following description. Thin walled glass cylinders, 3—5 cm. in diameter, having capacities of 30—100 cc., were used as the electrolytic cells. The anodes were spirals of platinum wire, 1—2 mm. in diameter, and the cathodes, rectangular strips of platinum foil almost wide enough, when folded into cylinders, to completely surround the spiral anodes. [The use of a platinum spiral, having a comparatively small surface as anode—only about one-tenth of the surface of the cathode—is a device of Crum-Brown and Walker's for increasing the density of the current at the anode in order to give the most favourable conditions for the union to molecules of the nascent radicals then liberated.] Accidental contacts between the electrodes were provided against by inserting a narrow glass ring between them at the bottom of each cell. The wires connected with the electrodes passed through perforations in the corks closing the cylinders. The necessarily high electrical resistance offered by the solutions caused some heating; each cylinder was, therefore, surrounded by a water-jacket. When the quantity of solution was small, or the resistance very high, the capacity of the cell was diminished and the electrodes brought very near to each other by winding the platinum spiral about a stout glass cylinder closed at its lower end.

The current was furnished by a battery of 49 "crow foot" gravity elements set up in series; this source being used because a dynamo and storage cells were not available, and a constant current could be derived from it for weeks together without requiring much attention to keep it in order. The internal resistance was very high, often two ohms to the cell,

so that the current obtainable was always weak—a disadvantage which was partly remedied by multiplying the number of electrolytic cells and connecting them in parallel circuit.

From the particulars given of a number of substances produced by this system, it appears that certain chemical operations will possibly find a strong competitor in electrosynthesis, not merely in the experimental laboratory, but in industrial factories. Apart from the possible commercial importance of Mulliken's work, those who are interested in the theoretical aspect of certain electrolytic problems will find it interesting and profitable to peruse his paper.

Of an entirely different class, but of even more practical importance than the above syntheses, are Dr. Elbs's successful experiments in the production of the ammonium salt of persulphuric acid. These are described in a recent issue of the *Journal für Praktische Chemie*. Dr. Elbs appears to have worked upon somewhat similar, but improved, lines to those of Berthelot. The apparatus used is as follows: A spiral of platinum wire forms the anode whilst a piece of sheet lead, bent in the form of a cylinder, does duty as the cathode; this surrounds a porous cell. The outer liquid consists of equal portions by volume of water and sulphuric acid, and the inner liquid of a saturated solution of ammonium sulphate in sulphuric acid diluted with eight times its volume of water. The outer containing vessel is jacketed with pounded ice or a stream of cold water. A current of 2—3 ampères is allowed to traverse the apparatus for four hours when the contents of the inner cell are filtered through glass wool which retains the crystals of ammonium persulphate. The filtrate is then again electrolysed.

Dr. Elbs's process gives an average yield of 65 per cent. and it is believed that this can be increased to 85 per cent.: in operation it is stated to be simple and economical.

AN EVAPORATIVE SURFACE CONDENSER.

SOME figures are given by Mr. Fitts in a paper presented at Chicago to the Engineering Congress upon evaporative surface condensers, or, as we term them, atmospheric condensers. The condenser is formed by a pair of rectangular end chambers, connected by horizontal rows of tubes, each row of tubes being immersed in a pan of water, so that there is a space between the surface of the water and the bottom of the pan above; through these spaces a fan draws air. Steam to be condensed enters the top of one end chamber, which has a horizontal division at half its height, the steam passing through the upper tubes to the other end chamber and back through the lower rows of tubes to the outlet in the lower division of the first chamber and thence to the pump.

The space occupied by a condenser which has been tested is: Floor space, 5 feet 4½ inches by 1 foot 9¾ inches, height, 4 feet 1½ inches. There were 210 tubes arranged in 27 rows of eight and seven in a row, all of brass, No. 24 B.W.G. and ¾ inch external diameter and 4 feet 9½ inches long. The internal cooling surface is 176½ square feet. The water pans which extend the whole length and width of each row of tubes are $1\frac{7}{16}$th inch deep, and the total water surface is 234·8 square feet. Every third pan receives water which overflows to the next two below.

In a test made in condensing steam from a boiler at 65 lbs. gauge pressure with water supplied at 60°, the results were:—

Temperature in pans under top sets of tubes 140°; in lower pans 115°; hot well 149°; atmosphere 70°; dew point 62°; speed of air pump 90 strokes per minute, fan 740 revolutions per minute; air velocity 2,300 feet per minute; air moved per minute 6,500 cubic feet; horse-power to drive fan 1½; barometer 28 inches; water used per hour 1,350 lbs.; steam condensed per hour 900 lbs.; vacuum 16½ inches = 18½ inches if barometer had been at 30 inches.

Owing to some defects in the pans, a quantity of the cooling water was lost, which accounts for the large excess over the steam condensed; otherwise, it may be assumed that the water used will equal the steam condensed, and as a condenser reduces the steam consumption of an engine, the use of an atmospheric condenser will really diminish the amount of water required by any steam plant.

This test affords a rough indication of what may be expected from the system, this small apparatus having dealt with the equivalent of steam of 75 to 80 horse-power. Even where no use is made of the vacuum as a source of power, there would be an economy in many cases where feed water is dirty or scale producing. Where the boilers have a good draft, this may be utilised to draw the air through the condenser into the ash pits, or the fan may be used as a ventilating fan, a use to which it might very well be put in the vicinity of a theatre or other large public building.

The atmospheric condenser, indeed, presents itself as a solution of some of the difficulties which attend upon a city station, and merits the consideration of engineers most decidedly. So many engineers are trammelled by the idea of a cooling pond, for condensing water, of large area and exposed to the sky, that they do not perceive that the same results can be had with a portion of the area cut into bits and superposed in layers, and made efficient by a multiplication of the quantity of air moving over the surface.

We might point out that if no better place is at hand for a condenser, the roof may be utilised very well for the purpose. By a properly constructed pump, the work of circulating the water may be kept down to the simple duty of lifting that proportion which is lost by evaporation, &c., in an electrical station. The circulating pump may be placed on the roof and driven by a small electric motor. The water condensed will gravitate through the feed pump to the boiler, and in so doing could be made to return power enough to raise the water necessary for making good the evaporation. Where the condenser is thus placed high, it is, however, necessary that there be an air pump at the same level when the down pipe is kept full of water, or there can be no air outlet. The same effect is obtained if the pipe to the air pump is carried from the highest point, taken up a few inches and then down to the pump below; but the air pump must be an *air* pump in the narrower meaning of the term, and the disposal of the water must be effected by a separate pump—as by the feed pump directly to the boilers.

Where a roof of large area and well exposed, is available to deal with a comparatively small horse-power, it may be very well made to serve as a cooling surface for condensing water, which in such a case could simply be circulated over the tubes of the surface condenser. Indeed, the principle may be so variously applied, and should yield such a good return, that there can be few places where it could not be applied with advantage.

REVIEWS.

La Mort et les Accidents causés par les courants électriques de haute tension. Par le Docteur FRANCIS BIRAUD, Médecin stagiaire au Val-de-Grâce. A. Stork, Lyon; G. Masson, Paris.

This work appears at an opportune moment. The battle between high and low tension has waged particularly strongly over the all important point of safety, safety alike to the operator and to the general public. While there can be no doubt at all to the unbiassed mind as to the relative safety of the two systems of supply, there have not been wanting most able advocates and most potent arguments on either side. The matter was practically put in a nutshell by one of the gentlemen who took part in the original controversy at the time of the Board of Trade enquiry prior to the granting of Parliamentary powers to public electric supply companies. It was then suggested that a tame cat was in the long run a safer thing to deal with than a caged lion, however strong the cage. The exponents of the caged lion type of supply have ever striven to make their cage strong enough, but while there is no great difficulty in making the bars strong enough, the lion always seems to find some means of putting his paw between them, with sufficient liberty of action to injure or kill one of his attendants, or sometimes one of those who, in the course of their daily occupations, are brought too near the cage. Be it remembered, the arguments contained in the work whose scope we propose to review, are simply as to the effect of high tension electric

currents as means of causing accidents or death. The work does not deal with the commercial advantages of high or low tension, nor with any suggestions as to which system should be adopted, nor is the object of the author to hinder the progress or in any way detract from the value or advantage of electric light, or to attempt to throw discredit upon any particular system. Dr. Biraud has collected a series of authentic instances of trouble arising from electric shocks, and considers that he is performing a duty in showing that defective installations, badly designed or badly supervised systems of distribution, and the familiarity with electric light dangers which proverbially breeds contempt of them, may be the source of more or less severe accidents, and that the pathology of accidents so caused calls for very special study, and opens up an entirely new field of research.

The author has succeeded in getting together the very varied collection of instances of accidents due to high tension currents, by publishing in several scientific journals an appeal to their readers to communicate to him any instances which may have come under their personal observation.

The questions included in this appeal covered very completely all the information upon the subject that it would be reasonable to expect to obtain, and while not going perhaps into so great detail as the American Senate did when on a similar quest, the replies have elicited many circumstances alike instructive, interesting and suggestive.

When a human being completes an electric circuit through his body, the effect, whether the current is continuous or alternating, is of the nature of a shock. This shock may be accompanied by acute pain, loss of consciousness, and even death. Be the consequences fatal or not, one is at once led to the question, which is the factor producing this shock; is it a function of the electromotive force, or of the current density?

This question has, we know, received considerable attention at the hands of physiologists, notably D'Arsonval and Weiss, and there is little doubt that we must look to the physiologist to answer the question, to enquire into and observe the signs attending death by electricity; to determine if death is produced by inhibition of the heart's action, or from cessation of respiration; or if it is due to or accompanied by any alteration in the construction of the blood corpuscles, as suggested by the various existing hypotheses. Again, is loss of consciousness instantaneous, and are the muscular movements or other symptoms observed after the shock has been received, due entirely, or only in part, to reflex action?

A diagnosis of a case which is not accompanied by fatal effects suggests rather a field for the practical physician. There must be a pathology, so to speak, of electric accidents, as there exists a pathology of effects due to railway travelling, such as cerebral and spinal troubles referable to vibrations and other shocks received either in the ordinary course of long continued railway travelling, or as a result of some slight accident. It is even to be anticipated that clinical observations may lead to therapeutic conclusions of great value. These facts are not overlooked by the author, who divides his work into chapters dealing with the history of the subject, and with observations relating to physiology, pathology and therapeutics. There are also chapters upon the medico-legal and hygienic aspects of the subject, and finally the author devotes considerable space to a study and description of electrocution.

In order to give our readers opportunity of judging of the very complete manner in which these subjects are dealt with, we propose to touch briefly upon the most important facts chronicled in these chapters.

The author, in his historical epitome of scientific observations of effects caused by electric currents, records that Priestley, in 1766, was the first to establish the fact that death caused by an electric shock need not of necessity be accompanied by any lesion of the tissues. He then quotes Marat, who worked independently of Priestley, at some length. Marat's researches were carried out chiefly on small animals, birds, rats, frogs and cats. The means at his disposal did not permit of his carrying out his experiments on a large scale, as he was, of course, limited to Leyden jars charged by influence machines for his source of electric energy. Moreover, the fact that no measurements were made of the current or electromotive force detracts greatly from the practical value of his researches.

The invention of the primary battery enabled experimenters to extend their field of operations somewhat, but they were not in a position to measure either the current or the electromotive force of the discharge. An interesting result should be recorded at this stage. Cats which had been subjected to a discharge from a powerful primary battery,* appeared at first to be dead, but subsequently revived, and ran about the laboratory as if nothing had happened. The earliest contribution to our knowledge on this subject appears in a thesis by M. Grange, published in Paris in 1885, but owing to the fact that this gentleman confined himself to a very hypothetical consideration of only two cases, the work is not of importance.

At about this time American medical men began to turn their attention to the clinical aspect of cases of electric shock which did not terminate fatally, but the results of these observations have never appeared in any systematic form. About the same time the number of fatal accidents in America suggested to the minds of the authorities the substitution of "electrocution" for hanging. This matter was taken up without mature deliberation, and certainly on insufficient premises. The pathology of accidents due to electrical agency had not been sufficiently studied, and practically nothing was known as to the resistance of the human body. The following table, extracted from a work by Dr. Castex, entitled, "Résistance Electrique du Corps Humanie," and published in May, 1892, is the first systematic enquiry into this subject. The figures denote the resistance in ohms between the hands:—

Pouillet, 1,061 ohms.
Lenz, 2,100 ohms.
R. Remak, 1,000 to 1,600 (Siemens unit).
Ischeriew and De Watteville, 3,000 to 80,000 ohms.
Gartner, 100,000 to 300,000 ohms.

These figures indicate that considerable uncertainty, to say the least, exists as to the resistance of the human body, if the results of the above experimenters are to be trusted equally.

More recent investigations have shown that the resistance of the human body is apparently never constant, that it varies with the state of health of the patient, with the amount of moisture of the skin, and with the applied electromotive force. So far we have stated the results of experience gained with continuous currents. Dr. Biraud raises the important question, as far as electrocution is concerned, as to the variation of the body resistance when exposed to alternating currents. He refers to the experiments of Kundt and Kohlrausch carried out with a Wheatstone bridge, in which a telephone is substituted for the galvanometer, to those of Swinburne, who calculated the resistance by Ohm's law, measuring the current density by a specially designed galvanometer, and the electromotive force by an ordinary voltmeter, and to many others. The values obtained by these several experimenters differ very widely.

Messrs. Brown, Kennelly, and Dr. Petersen have carried out experiments on upwards of 200 persons of different ages in America. These results agree pretty fairly, and show about 1,000 ohms resistance from hand to hand. This is a remarkably low value. But in these experiments a very good contact was ensured by immersion of the hand into vessels containing some caustic solution.

The author mentions some very complete experiments made by Dr. W. H. Stone, in England, as long ago as 1885. Dr. Stone's method of making contact was to immerse the arms or legs of the patient in a solution of brine, and to use large lead electrodes. He was the first to show that the human body possessed very considerable capacity, and his experiments also showed that effects due to polarisation gave rise to a counter electromotive force. Dr. Stone eliminated the errors due to polarisation, by using Mance's method, and those due to an imperfect contact by using very large electrodes as described above. The results of these experiments gave 939 ohms from one foot to the other, and 905·45 from one foot to a hand of an adult. This extreme accuracy is perhaps unwarranted, as more recent investigations show that the resistance of the human body is dependent upon its physiological conditions.

(To be continued.)

* There is no means of determining the size of the battery.

Town Councillors' Handbook to Electric Lighting. By N. SCOTT RUSSELL. Biggs & Co., London.

The author states that this work is intended to afford county councillors and others who are interested in electricity some information likely to be of use to them in dealing with questions of central station lighting, and to convey that information in as simple and popular form as possible.

The contents of this handbook appeared originally as a supplement to our contemporary the *Electrical Engineer*. In the course of some comments upon it, we pointed out some serious errors. For the most part we are glad to note that these blemishes have been rectified, and to those who wish to gain a general knowledge of the subject of town lighting, we can confidently recommend the book.

In such a work, mathematical accuracy would be needless, certainly it would be unappreciated. Useful information is given concerning parliamentary procedure, the position of local authorities under the Acts of 1882 and 1888. A special feature is a table of expenditure, which should be extremely useful in affording an idea of the cost of different parts of an electric lighting system. Members of electric lighting committees should possess a copy of the work.

British Locomotives: their History, Construction and Modern Development. By C. J. BOWEN COOKE. Whittaker and Co., London and New York.

The object of the author in the production of this work is to place before his readers a non-technical, and yet intelligent and reliable description of the railway locomotive—something which, while not ignoring the trained mechanic, may appeal to the general reader interested in railway working.

The book is well illustrated, and contains amongst other matter much historical information, not merely with respect to the introduction of steam locomotion, but also on many of the more important parts leading up to the development of the locomotive of the present day. The various valve motions, the boiler, boiler fittings, cylinders, &c., are fully described, as also how the engine is put together in the fitting shop. Tenders and brakes, with much other information, is followed by two chapters on modern locomotives, in which the author produces illustrations and data of the various types of engines used by the several railway companies for passenger and goods traffic. Here we have also an interesting table showing the mileage and number of engines owned by each of the companies. Naturally, the L. & N.W. heads the list with 2,722 engines, the Midland coming next with 2,296, the Great Western being third with 2,049. The following total numbers may be interesting :—

	Miles.	Engines.
English railways	14,117¾	15,673
Irish "	2,551	698
Scotch "	3,178¾	1,899
	19,847½	18,270

The number of engines being not far short of the mileage of line !

The chapter on combustion and consumption of fuel affords interesting information, from which we gather that the coal consumed by passenger engines varies considerably, not merely with the load but equally with the speed, as might be readily conceived. This in instanced by results taken from actual trials made with approximately the same loads and over the same road. In one instance where the speed did not exceed an average of 24 miles, the consumption of coal was 21·3 lbs. per mile, and evaporation of water 9·77 lbs. for each lb. of coal burned. In another, where the speed attained an average of 45·6 miles per hour, the coal consumed averaged 57·6 lbs. per mile, the water evaporated being 7·6 lbs. per lb. of coal consumed ; the total weight moved being in each case practically 325 tons, and the distance worked 105 miles.

Very little is said with respect to liquid fuel—rather an interesting question in these times of coal strikes—but that little appears to be favourable to a combination of liquid fuel and coal, such as is at present experimentally in use on some of the locomotives of the Great Eastern Railway.

Mr. Cooke's book will, we doubt not, prove not only interesting but instructive, and is deserving of a wide circulation.

Continuous Current Dynamos and Motors. FRANK P. COX. New York : W. J. Johnston Company.

This work is a very elementary treatise, and, like the treatises on the dynamo and motor, now appearing daily in such great numbers, is merely a compilation from standard works. Why so many books should be written on the same subject, and treating it precisely in the same way, is a mystery.

The subject has been so often treated in the way it is treated in this work, that it is likely to be correct enough, and so may be of use to students in America beginning the study of the dynamo and motors. On this side, books with an equal amount of instruction in them can be had for a third of the price of this one (two dollars).

It is hoped in the preface that the work will prove of value "to those called upon to design electrical machinery who have not had the benefit of a thorough training in the science of electricity." This is a revelation to us. Imagine a man without a training in the science of electricity being called upon to design electrical machinery. Some of the American electrical machinery has every appearance of being designed without a knowledge of the science of electricity—in fact, a good deal of it—so that two dollars would be a good investment should it assist in the education of those called upon to design electrical machinery, and lacking the necessary training. Some interesting pages dealing with belt driving appear in the end of the work.

Alternate Current Transformers. R. W. WEEKES. London : Biggs & Co.

This is a model treatise on a subject very seldom satisfactorily handled. The principles involved in the design of economical transformers are described and illustrated cleverly and clearly. The calculations and formulæ are simple and easily applied.

It is not a very large book, but the author, by adhering closely to his subject, completely exhausts it. Such a work was much needed. Some makers of transformers require instruction, judging from their productions ; to them this work will be of great value. To the engineer, the draughtsman, and the student it will be of equal value as a guide to the construction of transformers.

The author takes different types of transformers, and calculates out the dimensions of the various parts. Diagrams given are drawn to scale, and costs are calculated. As the transformer is an invention which has come to stay, every electrical engineer ought to be familiar with its design. This little work will much assist in imparting a knowledge of the designs treated of.

AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION.*

(*Concluded from page* 515)

A CONTRIBUTION TO ELECTRO-THERAPEUTICS IN SALPINGITIS.

Dr. W. B. SPRAGUE, of Detroit, read a paper on this subject. The paper contained the histories of several cases of salpingitis, in which the author had been able to introduce an electrode through the uterus and into the Fallopian tubes at a time when these tubes were distended with pus. In each case there was a free discharge of pus, and prompt relief to the symptoms. Of course, in many cases, he found it impracticable to carry out intra-tubal galvanisation, but he had succeeded in other cases besides those reported in the paper, and in no instance had serious symptoms followed the treatment. His experience with this method extended over a period of three years. The treatment is necessarily of limited application, but is still extremely useful in appropriate cases. He used a sound with a curve slightly sharper than the normal one, and was of course careful not to use any force. If after the instrument has reached the cornu of the uterus a mild current be turned on, it will be found usually that in proper cases the instrument will soon pass on into the tube.

* Abstract of the proceedings of the third annual meeting held in Chicago, September 12th, 13th and 14th, 1893.

DISCUSSION.

Dr. SMITH said that many would not believe it was possible to catheterise the tubes, but when in Liverpool, Dr. Wallace had shown him no less than six cases in his hospital at one time, in which the uterine sound had been passed into the Fallopian tubes.

Dr. M. S. WEBER, of Detroit, referred to the sneering, doubting manner in which the first communication of the author on this subject had been received by the Michigan State Society, but he felt sure from what he had seen of Dr. Sprague's work that he was to be congratulated upon what he had accomplished.

Dr. MASSEY said that in 1880 he brought up this subject before the Philadelphia Obstetrical Society. At that time he had succeeded in emptying a number of tubes through the uterus. It should be remembered, however, that this was work suitable only for experts.

Dr. SARAH H. STEVENSON, of Chicago, said that she had long been convinced that such treatment was feasible, but had hitherto lacked the courage to try it.

DISCUSSION.—WHAT ARE THE POSSIBILITIES OF ELECTRICITY IN THE TREATMENT OF FIBROID GROWTHS? Those participating in the discussion were asked to do so under certain specific heads.

Dr. KELLOGG opened the discussion. He said that the improvement in the general health observed was due to the influence of the electric current on the abdominal sympathetic. The growth could be arrested, and in certain cases near the menopause retrograde changes could be expected. He had on a former occasion reported a series of 50 cases, in seven of which the tumour disappeared. Since then he had not been quite so fortunate. No one would think of employing anything but the constant current, except for the relief of pain. He usually employed a coulombmeter in conjunction with the milli-ampèremeter, thus avoiding troublesome calculations. His personal experience had led him to think that the phlebitis sometimes excited where very powerful currents are employed, is a decided help in bringing about retrograde changes in the tumour. He would not employ this treatment in rapidly growing tumours, unaccompanied by hemorrhage, in rapidly growing tumours appearing after the menopause, where ovarian cysts accompany the fibroid tumour, where the application is followed by inflammation, and in cases which do not show improvement after a reasonable trial. Recently he had been employing milder currents, because they caused less inconvenience, and admitted of more frequent applications. 75 per cent. of his cases had been symptomatically cured; in 55 per cent. the tumour had been very much reduced, and in 14 per cent. it had entirely disappeared.

Dr. FELICE LA TORRE, of Rome, Italy, sent a contribution to the discussion. The galvanic current, in his opinion, certainly arrests hemorrhage, but the diminution in size of the tumour was rare. He discussed a number of theories as to the action of the current, and concluded that it acts chiefly in two ways, viz.: (1) by causing energetic contraction of the uterus, and in this way causing compression of its vessels and arrest of hemorrhage; (2) by producing a disturbance in the molecular interchange of the elements of the tumour, by which the nutritive juices are transformed into peptones or other substances which are absorbed or eliminated by the kidneys, thus giving rise to absorption of the fibroma.

Dr. A. LAPTHORN SMITH had found that this treatment arrests hemorrhage, even in very desperate cases, and the general health is at the same time improved. In about half of his cases there was arrest of growth, and in about half of these the tumour had diminished in size. In only one case was he sure that the tumour had entirely disappeared. The treatment is contra-indicated when there is reason to believe there is pus in the tubes. He favoured the use of mild currents, and the sittings not oftener than twice a week. He had never given in any one case of this kind more than 100 applications, and he usually observed marked improvement after about 15 applications.

Dr. CLEAVES said that she had found the treatment of especial value in intra-mural growths, and that in this class of tumours the pressure symptoms were invariably relieved, the general health improved, and in hemorrhagic cases there was an arrest of the hemorrhage. In a limited number of cases there was some anatomical retrogression, but in no instance had she observed a complete disappearance of the tumour. She believed that the arrest of the hemorrhage was as largely due to the cataphoric action of the current as to the chemical cauterisation. She called attention to the experiments made by Mr. Stewart, of Owen's College Laboratory, by which he had demonstrated the increase of liquids at the negative pole and also an accumulation of salts at the negative pole. In order that there should be such an accumulation, it was necessary that first there should be a decomposition and redistribution of the salts, fibroid tumours and inflammatory products are rich in salts, especially in chloride of sodium, and are very largely dependent upon the presence of these for the maintenance of their nutrition and growth. The experiments to which she referred go to show that the removal of a considerable proportion of the salts, even if that removal were temporary, would result in the destruction of the tissue, while the removal of a small proportion would effect its nutritive activity. She had also found the induced and static-induced currents of very great value as an adjuvant to the treatment of fibroid growths by means of the constant current. Cases in which the static-induced had been used noted a marked sense of well-being, buoyancy and lightness, not only in the pelvis, but in the entire abdominal region.

Dr. MASSEY said that in a series of 80 cases, in all of the 34 hemorrhagic ones, the hemorrhage was controlled; in 10, the growth was simply arrested; in 49, there was distinct retrogression; and in seven, the tumour disappeared. The average current strength was 50 to 150 m.a., and the duration of active treatment varied from six weeks to three months.

Dr. ENGLEMAN has had much the same experience as the other speakers. He did not doubt that the tumours could be reduced in size provided they were placed under treatment at the proper time; but he was also compelled to admit that he had seen some very large tumours disappear without any treatment, and this had been the experience of other surgeons. We should be very careful not to employ electrical treatment if there is reason to suspect that the tumour had already begun to undergo malignant metamorphosis, for under such circumstances electricity will certainly aggravate the condition.

The PRESIDENT said that one of the principal uses of electricity in some cases of large tumours is to so improve the general health of the patient when it is so much deteriorated as to admit of operative procedures when they are demanded. He had observed considerable retrogression in favourable cases, but had never seen a complete disappearance of the tumour. It was almost always possible to effect a symptomatic cure. He preferred strong currents and short sittings, and did not think much could be accomplished in less than six months. In recent growths, and in myomata, he would expect retrogression. He advocated the use of the positive pole in myomas and where hemorrhage was a symptom, and the negative pole in fibromas. He called special attention to the danger of producing stenosis even with negative applications of only 50 m.a. when the cervical canal is included in the action exerted by the current.

Dr. HAYES thought a useful adjuvant to the ordinary Apostoli treatment consisted in applying the static induced current by means of abdominal and vaginal electrodes.

IMPROVEMENTS IN ELECTROSTATICAL OR INFLUENCE MACHINES.

Paper by Dr. Wm. James Morton. The improvements related to important points in mechanical construction and to utilising Dr. Morton's discoveries for converting statical discharges into currents. There are two directions in which influence machines are of use to physicians; one, the spark and its modifications, the other the Morton currents. The former are familiar to all, the latter exhibit the phenomena of high frequency, high potential currents, now familiarised by the labours of Tesla, Elihu Thomson, and D'Arsonval.

As a result of continued medical work for 13 years with statical machines, the writer had had constructed by the Galvano-Faradic Company, of New York City, a machine which embodied in his opinion every modern advance. It was fundamentally of the Wimshurst-Holtz type; it had eight revolving plates, each one 30 inches in diameter; it was provided with a simple device, by aid of which the physician could employ at will the spark, spray, static induced and the transformer current. In its present shape the new machine answered every purpose in medicine to which influence machines could be put. It was known as the Morton-Wimshurst-Holtz machine.

THIRD DAY.—September 14th.

EVENING SESSION.

Dr. WILLIAM J. MORTON exhibited a new transformer for use with influence machines. The transformer consists of two flat spirals placed in an ebonite box containing oil. The static induced current is led into one coil, and from the secondary coil the current passes to the patient. This current produces a peculiarly vigorous but painless muscular contraction.

Dr. MORTON also exhibited a helmet such as was employed by Charcot in the treatment of disease by means of rapid percussion. The vibrations are produced by a small electric motor. The application of this helmet uniformly and almost immediately relieves the sensation of fatigue, and in some cases it will relieve, at least temporarily, most excruciating neuralgic headaches.

Dr. E. H. WOOLSEY, of California, called attention to the fact that the relief was probably obtained through the agency of the spine, and was similar to the relief experienced by some when riding on horseback or on a railroad.

FARADISATION AS IT WAS, AND AS IT IS WITH THE CONTROLLABLE AND RECORDABLE CURRENT, AS PROVIDED BY A NEW APPARATUS.

Dr. GEORGE J. ENGLEMAN, of St. Louis, read a paper with this title. The author described his method of separating the interrupter from the faradic coil so that the current of the latter may be independent of the slow or rapid action of the vibrator. The apparatus is provided with a comparatively slowly revolving wheel by which one can easily compute the number of interruptions. In view of the fact that the full current from the fine wire coil is scarcely bearable when the interruptions are 2,000 to 3,000, and yet when they are 15,000 the current is scarcely perceptible, the importance of determining the rate of vibration is evident. Personally, he thought the useful limit was 50,000 interruptions. Again, where external irritation is desirable, a short coil of fine wire is required, whereas, an entirely different construction is needed for producing a sedative effect. In addition to noting the number of vibrations of the interrupter, it has been found that the essential points to be recorded are the resistance, the number of windings, and the fineness of the wire.

DISCUSSION.

Dr. MASSEY remarked that a very objectionable feature of the ordinary faradic apparatus is the rapid oxidation of the contact surfaces of the vibrator.

Dr. HERDMAN said that this objection had been done away with in the new apparatus, because the rubbing of the contacts on the brake wheel sufficed to keep these surfaces bright. He did not think the physiological limit of such an apparatus had yet been determined.

Dr. ENGLEMAN replied that he thought the physiological limit had been reached, for experiment had shown that the best physiological

effects were obtained when the number of windings did not exceed 13,000.

The following papers in the absence of the writers were read by title:

"Notes upon some uses of Galvanism in Surgery." By D. B. D. Beaver, M.D., of Reading, Pa.

"An Unconsidered and Important Factor in the Explanation of the Action of Electricity in Uterine Disease." By Henry McClune, M.D., of Cromer, England.

"The Present Position of Electricity in the treatment of Eclopic Gestation." By A. Brothers, M.D., of New York City.

"Uterine Displacements and their treatment by Electricity." By G. Bitton Massey, of Philadelphia.

"Synovitis treated by Cataphoresis." By F. H. Wallace, M.D., of Boston, Mass.

"The Primary Action of the Galvanic Current on the Blood. It increases the Amount of Ozone it Contains, as shown by Chemical Tests of the Blood in the Arteries." By J. Mount Bleyer, M.D., and M. M. Weill, M.D., of New York.

"The Use of Static Electricity in Incipient Insanity." By W. E. Robinson, M.D., of Albany, N.Y.

"The Conservation of Energy as a Successful Factor in Electro-Therapy." By Horatio R. Bigelow, M.D., of Philadelphia, Pa.

Dr. W. J. Herdman, of Ann Arbor, was elected president, and Dr. Margaret Cleaves, of New York, secretary; Dr. Franklin H. Martin, of Chicago, and Dr. A. Lapthorn Smith, of Montreal, vice-presidents; Dr. R. J. Nunn, of Savannah, Ga., treasurer, for the ensuing year. It was decided to hold the next meeting in New York City, on the last Tuesday in September, 1894.

LEGAL.

THE ELIESON ACCUMULATOR SYNDICATE *v.* THE EARL OF GALLOWAY.

ON Tuesday, before Mr. Justice Kennedy, without a jury, this case was heard. Several of the daily papers talk of Mr. *Edison*, the celebrated American electrician, but this should be Mr. *Elieson*. This was an action to recover £400 as money due upon 2,000 £1 shares in the plaintiff company, and the defendant by his pleadings denied that he had become a member of the company, or had incurred any liability in connection with shares in it. Mr. Flavell Salter was for the plaintiffs, and Mr. Lockwood, Q.C., and Mr. Pollard for the defendant. The hearing of the case was commenced several months ago, and it was now continued. The questions in the cause turned upon a great deal of correspondence and of oral evidence. Mr. Walter Smith, an accountant, was the promoter of the proposed company in 1892, and he got into communication with Lord Galloway, and received from him two sums of £50 each. The case for the plaintiffs was that this money was to be used as a deposit upon the shares proposed to be allotted to Lord Galloway. The defendant denied that he had ever paid this money in respect of the shares upon which he was now sued. It had been represented to him that Mr. Smith had an option for sixty days from Mr. Elieson to sell to the company to be formed his English patent for £6,000. This, however, was all subject to confirmation by a Mr. Pellas, who was in partnership with Mr. Elieson. There was, however, according to the evidence for the defence, no such confirmation, and no such company as was contemplated was ever formed. The patent had, in fact, been sold to another company. Under these circumstances, it was said, that even if Lord Galloway had agreed to subscribe for shares in a company, such a company as was then contemplated had never been formed, and he had incurred no liability in connection with the plaintiff company, which differed most materially from the one that had been contemplated.

Lord SACKVILLE CECIL, brother-in-law of the defendant, said that in the early part of these transactions he saw Mr. Watson Smith, and he was not satisfied that the schemes were such as he could recommend Lord Galloway to go into. He never heard until a letter of October 20th that any shares had been allotted to the defendant.

The EARL of GALLOWAY said that he signed documents making applications for shares in companies to be formed, and, to the best of his recollection, he never gave Mr. Watson Smith any authority to apply for shares in any other companies than those referred to in a prospectus which he saw, and he never requested that any shares should be allotted to him. The first intimation he had of the allotment of any shares was by the letter of October 20th.

Mr. Justice KENNEDY said that he would look through his notes before giving his decision.—Judgment was postponed.

THOMPSON *v.* COWLES SYNDICATE, LIMITED.

THIS was a case before Mr. Baron Pollock in the Queen's Bench Division, in which the plaintiff, Mr. George Thompson, the agent for a firm of foreign carbon manufacturers, sought to recover from the Cowles Syndicate, Limited, a Staffordshire firm, carrying on business as aluminium manufacturers, the sum of £293 0s. 1d., in respect of carbon supplied to the defendants. The defendants pleaded that the carbons supplied were not of the guaranteed quality, being soft and insufficiently baked, and were quite unsuitable for the purposes required. They further counter-claimed for a sum of £400 as special damage caused by the use of the inferior carbons.

The case was argued at considerable length, and his Lordship gave verdict for the defendants, with costs, and judgment for the plaintiff on the counter-claim with costs.

On the application of plaintiff's counsel, a stay of execution was granted on the payment of £100 into court.

THE MEDICAL BATTERY COMPANY.

THIS was the adjourned petition, which came before Mr. Justice Vaughan Williams on Wednesday. Mr. Jenkins appeared in support of it on behalf of the petitioning creditor, Mr. T. B. Browne. Since the presentation of the petition the company had passed a resolution to wind up voluntarily. The total debenture issue was £8,150, and of this it appeared £7,000 was held by directors or other officials of the company. Mr. C. B. Harness held £4,500, Clara Harness £200, other directors £1,500, and Mr. Fleet, the solicitor, £400. He at first held £800, but transferred £400 to Martha Harness.

Mr. MACNAGHTEN appeared for six creditors for £2,800, and he remarked that this was plainly a family affair, and that an investigation by a public officer would lead to a result beneficial to the creditors. Mr. BRAMWELL DAVIS also asked for a compulsory order on behalf of Sir William Leng and the *News of the World*.

Mr. BOXALL, representing shareholders to the amount of £43,800, favoured the suggestion as to voluntary liquidation, so that a valuable business might continue.

The JUDGE: I am not aware that there is such valuable business (laughter). A minute book having been asked for and produced, was found to be locked. Finally, the Judge ordered the continuance of the order for voluntary winding-up, under supervision, for a week, and also ordered the production of the key of the locked minute book.

DEATH OF MR. ANTHONY RECKENZAUN.

IT is with the deepest sorrow that we announce the death of Mr. Anthony Reckenzaun. This regret will be shared by the whole of the industry; but to those who came into personal contact with him, the event will be keenly felt. He had for many months suffered from a malignant disease, and it was feared he would never regain his former health. Unfortunately these fears have been realised, and to-day we mourn the loss of one of the worthiest, the cleverest, and the kindliest members of the profession of electrical engineering. Mr. Reckenzaun was, comparatively speaking, a young man. He was born at Gratz, in Austria, in 1850. After being educated at the Polytechnic School, or College of Gratz, in a manner suited to his future career as an engineer, he went into the ironworks of his father. From thence he came to England in 1872, joined Ravenhills, the engine makers, eventually following the transfer of the business to Easton & Anderson. He was with Donkins, of Bermondsey, for a short time, but afterwards returned to Easton & Anderson. Apart from his engineering duties, he found time to give series of lectures to the workmen employed at the Erith Works of Easton and Anderson. He married in 1877 Eliza, daughter of Mr. Wright, R.N. Some time later he determined to make electrical engineering a special study, and with this end in view visited the Paris Exhibitions of 1879 and 1881, besides attending Prof. Ayrton's lectures at Finsbury. He joined the Faure Company in 1882, but only stayed there about a month, and then joined the E.P.S. Company. He left this company in 1885, but remained connected with it for several months superintending the preparation of an accumulator car, which was run on the Queen's Road branch of the South Metropolitan Tramway Company. This trial fully demonstrated the practicability of accumulator cars, and was visited by deputations from various municipal bodies; but for reasons not necessary to mention the car was withdrawn by the E.P.S. Company. It must be mentioned that before severing his connection with this firm Mr. Reckenzaun designed his first electric launch. Starting in 1885 as a consulting electrical engineer, especially in connection with traction, he was, from the incorporation of the Keys Electrical Company, their consulting engineer until quite recently. For the last two years he was also specially retained by Messrs. Greenwood & Batley as their consulting engineer. He assisted the General Electric Company in a similar capacity for a considerable time. It is safe to say that the value of his labours will be only fully appreciated when electric traction comes to be generally adopted in England. The whole subject was investigated by him in the most persistent manner. Many of his improvements in details are in daily use in America. He designed a special motor for cars which combined lightness and efficiency; a peculiarity of this motor was that it had no cast-iron in its construction. He patented a method of regulating the speed of motors by changing the resistance of the field coils; this was afterwards copied by Sprague and several others; switching apparatus, the frame-

work of cars, and other matters, were also improved. He enquired into the various kinds of gearing, and finally concluded that there was a fruitful field for investigation. The result was that in the year 1883 he made a worm gearing set which at the lowest useful speed gave an efficiency of 80 per cent.; it was afterwards found during tests made at the Oerlikon Works, and at the Electric Car Company's works in Philadelphia, that further improvements had brought the efficiency up to 85 and 90 per cent. This form of gearing is extensively used at the present moment. Mr. Reckenzaun demonstrated the utility of accumulators for motive power purposes by fitting up a boat, the well known *Volta*, and making the double journey between Calais and Dover. Numerous lectures and papers have been given by him before scientific societies. For his paper on "Electric Locomotion," read before the Society of Arts, he was awarded a silver medal, and last year the Institution of Electrical Engineers awarded him the Paris Electrical Exhibition Premium for a paper on "Load Diagrams and the Cost of Electric Traction." He wrote what may be termed a classical series of articles for the ELECTRICAL REVIEW on "Practical Notes Concerning the Construction, Use and Management of Storage Batteries." These were published during the latter part of 1887 and ran over many issues. His contributions to the ELECTRICAL REVIEW extend over a number of years, the most recent of which were an exceedingly able series of articles on "Multiphase Transmission and Distribution of Energy," and "Facts and Figures Anent Electric Traction." The latter paper is one of the most important treatises on the commercial value of electric traction ever written. He was the author of a work on "Electric Traction," recently published by Messrs. Biggs and Co.; his wide experience well fitted him for writing such a treatise, and it will remain the standard text book for many years.

Although he was a keen advocate of accumulators for traction purposes, and perhaps accomplished more than any other engineer in original researches on their theory and practice, he was not blind to the usefulness of the overhead trolley system; its introduction into England gave him the greatest pleasure, and he watched the progress of the systems at Leeds and South Staffordshire with the closest attention. American engineers were as appreciative as English of the abilities of Mr. Reckenzaun, and whenever he visited America, a hearty reception awaited him.

The interment took place at the Tower Hamlets Cemetery, Bow, yesterday, the Unitarian service for the dead being read at the graveside. There were present, besides the mourners (Mr. Wright, brother-in-law of the deceased, and Mr. Reckenzaun's two sons), a number of his old friends in the electrical profession, including Prof. Silvanus Thompson, Mr. Gisbert Kapp, Mr. F. H. Webb (representing the Institution of Electrical Engineers), Mr. Raworth, Mr. W. B. Esson, Mr. Henry Edmunds, Mr. Dell, Mr. Robert Blackwell, Mr. Holroyd Smith, Mr. H. Alabaster, Mr. Max Binswanger, Mr. Hellmann, Mr. Collings, and Mr. Dawson and Mr. Bowman, who were Mr. Reckenzaun's two assistants. A large number of magnificent wreaths had been sent by friends.

We are giving effect to the feelings of all who knew him when we offer our deep sympathy to his widow and children.

CORRESPONDENCE.

Electrical Education.

The best thanks of all connected either directly or indirectly with electrical education are certainly due to Mr. Perren Maycock for introducing this discussion, and also to you, Gentlemen, for the publicity you have afforded it in the columns of your valuable paper. I have no doubt that other and more able pens than mine will take up this matter and bring it to the notice of the Examinations Committee of the City and Guilds of London Institute. I think it must be evident to anyone taking up the Institute's programme of technological examinations, that the syllabus in the ordinary grade examination in electrical engineering, relatively, covers more ground, and is of a more advanced standard, than the ordinary grade examinations in any other subject, and this is more than borne out by a glance at the questions set in the papers of the last two years, and I am certainly of opinion that there is not that amount of distinction between ordinary and honours questions from the point of view of practical knowledge that one would wish for, though, as no doubt is the case, a more detailed acquaintance with the subject is expected by the examiners in the answers to the honours questions; yet I venture to say that the ordinary grade questions cover too much ground for the work to be mastered thoroughly.

With regard to the departure taken by the City and Guilds in having a preliminary examination, I cannot say that I think the syllabus is suited to requirements, but as Mr. Brooks observes in his letter, it is impossible to judge how that syllabus will be interpreted by the examiners until after the first papers have been set; but surely, if an examination as such is worth working for, and passing, it is, or ought to be, worth the granting of a certificate to those who give satisfaction to the examiners in the same.

It appears to me that what is really wanted, and what I should very much like to see instituted, is an examination for those men for whom the ordinary grade examination is in a great measure intended, but who, unfortunately, it mostly fails to reach, on account of the questions being solely of a mathematical nature, I refer to wiremen and electric light fitters, and our local electricians, who are often in business as ironmongers, carpenters, plumbers, and gas fitters; these men do not wish to, and in many cases it would not be worth their while, to qualify as electrical engineers, but they make first class wiremen if properly taught, and I have no doubt that a class working for such an examination would be well attended, and the work would be of practical value to them, dealing fully on the systems of house wiring and fitting, different methods of jointing, value of insulation, size and length of mains and branches for various C.P. lamps, fire insurance regulations, &c. I do not mean to say that the Institute should grant certificates in electrical engineering to men passing an examination with such a syllabus, but by all means let them grant them certificates as electric light wiremen and fitters, and the Institute will be doing a *real* service, both to those who it ought to encourage in a knowledge of their work, and also to the electric lighting industry at large. I think most teachers will agree with me that it is a rush to cover the ground of the ordinary grade in one session's lectures and classes, and that we, the instructors in electrical engineering of the London and City Guilds, have not the time to spare for practical work which is so much needed, and if these men are not to get any practical work in the classes, where are they to get it? They must of necessity gain their experience in wiring small shops and houses, and this is not as it should be. The electric light gets into bad repute owing to slip-shod wiring, which is all too prevalent at the present time of keen competition. Such instruction as this would do much to improve this, and restore public confidence. I have more than once heard the remark from my students, "we do not want to be dynamo manufacturers, we want to know how to wire a house;" their time is too valuable for them to come to these classes if it is not to benefit them in their work, and my only regret is that under present conditions we are not able to give them more help in their everyday work, instead of trying to get them to understand that as $B = H \mu$ then $\mu = \frac{B}{H}$. I am also strongly of opinion that there ought to be more practical questions on house wiring and fitting, the chief commercial use of electricity of the present day, in the ordinary grade papers, for if these tended more to the practical, and less to the mathematical side of the question, we should have more practical electricians qualifying than as is now the case, boys straight from school, whose knowledge of mathematics, usually consisting of some formulæ they have learnt by heart, is at a premium, but whose practical knowledge is *nil*.

L. M. Waterhouse, A.I.E.E.,
Reg. Teacher L. & C. G.,
Lecturer in Electric Technology, Brighton Municipal Technical Institute.

Pollak's Method of Rectifying Alternating Currents.

In your issue of October 27th, you make some remarks about my invention for rectifying alternating currents for the purpose of charging accumulators and driving direct

current motors. The principal objection you make to its practical value is that it is too complicated, that its attendance requires too much skill, and that better plans for using storage batteries in alternating systems are in existence.

As to the first point, I may refer to the description of the device given in No. 41 of *La Lumière Electrique*, where it will be seen that the rectifier is by no means more complicated in design than an ordinary commutator of a direct current plant. There is, indeed, nothing easier than the maintenance of the brushes in such a position as to avoid sparking, the synchronous motor that drives the commutator being started simply by a hand-wheel. In charging accumulators, displacement of the brushes, and therefore attendance, is required during the first and last half hours of the charge, for the rest of the charging time no attendance whatever is necessary, due to the very slow increase of counter-electromotive force in that period. For motor purposes, where frequent changes of load occured, an automatic regulation of the brushes would be provided.

As to the use of storage batteries with alternating systems in general, I know that there are devices for exciting the fields from accumulators and the like; but my device is fit to replace the motor-dynamo used until now in plants of the system, viz., primary, alternating, and secondary direct currents. It allows of charging batteries during the time of small load, and to work in parallel with them during the period of highest load, just in the same way as with ordinary direct current systems. Furthermore, it allows the application of primary alternating currents of high tension to motor work, especially for electrical tramways, by means of transformers and rectifiers placed in due distances along the road.

I hope you will give room to this reply, which will settle some erroneous views about the practical use of my rectifying device.

C. Pollak.

NOTES.

Buxton and Electric Lighting.—An Electric Lighting Committee has been appointed by the Local Board.

Grimsby and Electric Lighting.—The Town Council last week resolved to apply for a provisional order.

Asylum Electric Lighting.—Mullingar Lunatic Asylum is to be lighted by electricity.

Worcester Electric Lighting.—It is said that the streets will not be lighted electrically until about the end of next year.

Wolverhampton Electric Lighting.—At the last meeting of the Town Council, Alderman W. H. Jones proposed the adoption of the report of the Lighting Committee, and remarked that the estimate for the electric light installation had been reduced from £23,000 to £18,000. The plant to be laid down would be of the class originally proposed, but the number of lamps would be reduced. This was agreed to.

Electric Wiring.—The concentric system of wiring with an uninsulated exterior conductor is receiving more extended recognition every day, and new ideas in its development are continually being added. The latest of these is published in the *Electrical Engineer* of New York, November 1st, in which the outer conductor is described as consisting of a tube in two parts, one of which can be removed for accessibility to the inner conductor. The description does not enter into sufficient detail to permit of our giving a full review of the system; but, to all appearances, it lacks the important feature which is essential to such a system, that of absolute continuity of the outer conductor at the joints. No screw or jamb junctions could be permanently relied upon in a system of wires that has to be hidden away in every part of a building, and the only method we know of at present for making secure junctions is that used in this country under the patent of J. D. F. Andrews, in which molten metal is used for effectually uniting the parts of the joints together.

The Late Engineering Exchange.—After a feeble existence of less than 18 months, the Engineering Exchange, which was at the time of its inception considered by many to be a superfluity, has decided to close its doors. It is not very often one observes a winding-up resolution in the *London Gazette* such as that published regarding this Exchange. Those individuals, who in a crowd 18 months ago agreed to support the Exchange, have now resolved that in view of the "apathy and lack of support shown *by the subscribers* to the Engineering Exchange, the company be wound up voluntarily." Mr. Arthur T. Salisbury-Jones has been appointed liquidator.

The Storage Battery in America.—The *Electrical Engineer* of New York takes a broad view of the present outlook for storage batteries. American engineers have been slow to avail themselves of the undoubted advantages of accumulators under certain conditions; but our contemporary says "that the proverbial American impatience for results, and inadequate attention to details in the early stages of the introduction of the storage battery, will account for many of the failures recorded." Actual experiments with storage batteries for traction have convinced our contemporary that there is a real field in America for this system. The subject has been taken up in a manner that bids fair to demonstrate that the storage battery, applied directly to the car can, under local conditions, hold its own against any other method of traction. The *Electrical Engineer* has come to this conclusion from trials made by the Waddell-Entz Company in New York. The cost of working with six cars in operation is 9·32 cents per car mile; the main items which make up this sum are 3·54 c. for generation, 2·24 c. for coal, and 1·54 cent is set aside for depreciation of batteries. This is a remarkably good showing; it is, however, such a distinct advance upon what has been done in England, that one is inclined to be cautious in accepting these figures for actual work. We should want more experience of the accumulators made by the Waddell-Entz Company before we accepted 1·54 cent. per car mile as sufficient for depreciation.

Street Railway Accidents.—We take the following from the American *Street Railway Gazette*:—The monthly classified list of street railway accidents and their causes is herewith presented. The number of casualties is slightly in excess of the record published a month ago, when 158 accidents were noted in the list. The consequences of accidents are far less serious than those classified last month. The number of fatalities is 38 compared with 49 a month ago, and 169 persons injured compared with 175. The results of the accidents due to horse cars when compared with those on cable and electric lines differ materially from what one has been accustomed to expect. While the number is relatively small the consequences are comparatively more serious. The horse car accidents were 10 in number, and to them were due 4 fatalities, 2 serious injuries, and 5 slight injuries. The classified list is as follows —

Number of places in which accidents were noted	47
Total number of accidents	162
Accidents to electric cars	99
Accidents to cable cars	53
Accidents to horse cars	10
Number of fatalities	38
Fatalities due to electric cars	24
Fatalities due to cable cars	10
Fatalities due to horse cars	4
Number of persons injured	167
Persons seriously injured by electric cars	45
Persons seriously injured by cable cars	33
Persons seriously injured by horse cars	2
Persons slightly injured by electric cars	54
Persons slightly injured by cable cars	28
Persons slightly injured by horse cars	5
Number of passengers injured	83
Number of employés injured	10

CAUSES OF ACCIDENTS.

Attempting to cross in front of cars	44
Collisions with vehicles	46
Attempting to board cars	41
Fell from cars	15
Injured while alighting from cars	11
Collision of cars	7
Passengers on footboard struck by vehicles	2
Collisions with railroad trains	1
Damaged grip	2
Fell while adjusting trolley pole	1

Dr. Tibbits's Affairs.—The case of "Warner *v.* Dr. Herbert Tibbits" came before Judge Lumley Smith, Q.C., on Tuesday, in the Westminster County Court, on an application to commit the defendant to Holloway. Defendant said the bill was for law-stationer work done for him with reference to an action he had pending. He was quite without means at present, but would soon have money. He was now living on what his friends sent him. An order to pay the debt by monthly instalments of £1 was made.

Sutton (Surrey) Electric Lighting.—The Local Board have under consideration a further report from Mr. Ed. C. de Segundo, in which it is suggested that it might be advisable for the board to establish a small installation, to commence with, to supply the shops and public buildings in the High Street. It is assumed that the board will make provision for the plant and machinery in the new public buildings, and, that being so, it is estimated that the necessary plant to supply 2,000 8-candle-power lamps would cost about £4,000. The total annual revenue is estimated to leave a profit of about £200, after paying expenses and interest on the borrowed money.

The Birmingham Central Tramways and Accumulators.—The following communication has come to hand from the E.P.S. Company:—"We beg to inform you that the Birmingham Central Tramways Company have, as you will see from the attached extract from their letter, after trying plates of other manufacturers for more than a twelvemonth, decided to renew the whole of the battery with plates manufactured by ourselves. We may also mention that two batteries of the original plates manufactured by the Electric Construction Corporation (the then owners of the E.P.S. patents), supplied more than two years ago, have been regularly working and giving excellent results. Owing to the manner in which the 'results' on this particular line have been persistently advertised, we trust you will give this statement due prominence.—The Electrical Power Storage Company, Limited, FRANK KING, H.W.D., *Manager*."

Extract of letter from
Kincaid, Waller & Manville,
29, Great George Street, Westminster, S.W.,
November 10th, 1893.

To the Electrical Power Storage Company, Limited,
4, Great Winchester Street, E.C.,

Dear Sirs,

Birmingham Central Tramways.

With reference to your favour of the 1st inst., we beg herewith to order from you, on behalf of the Birmingham Central Tramways Company:—960 positive sections, each of nine plates . . . . . 960 negative sections, each of ten plates . . . . . in exchange for . . . . . plates of other makers, as set forth in your letter of the 1st November. . . . . .

Yours faithfully,
(Signed) KINCAID, WALLER & MANVILLE.

The second paragraph in Mr. Frank King's letter states that out of the number of E.C.C. batteries supplied to the Birmingham Central Tramways Company about two years ago, two have been regularly working till now, and giving excellent results. Now this is not according to facts, as we have understood them. On the other hand the results which have, from time to time, been published by the Epstein Electric Accumulator Company, Limited, are based on indisputable facts, and their correctness can be easily ascertained. The statements as to the lifetime, reliability, and absence of repairs and renewals, were made publicly and confirmed by those best able to judge, being in possession of official figures. The experience and responsibility of the gentlemen who are entrusted with the management of the affairs of the Birmingham Central Tramways Company should offer a sufficient guarantee that the order given to the Electrical Power Storage Company is coupled with a maintenance clause, and it would be doubting their business capacity if one presumed that the terms of the contract are not more to the interest of the shareholders than the offer made by the Epstein Company to work the line and defray all expenses, with the exception of permanent way and general charges, for 70 per cent. of the gross receipts. But electrical and tramway engineers would no doubt feel greatly obliged if the information regarding the lifetime, repairs and renewals of accumulators, and the financial results to the supplying and maintaining company, were officially vouchsafed from time to time.

Ramsbotham and Electric Lighting.—The Local Board have resolved to apply for a provisional order.

Electric Lighting of Docks in India.—According to *Indian Engineering* the Kidderpore Docks are now illuminated by 39 2,000-C.P. arc lights.

Obituary.—The *Times* Paris correspondent reports the death of M. Paul Jousselin, chief engineer of the Paris-Lyons-Mediterranean Railway, and the inventor of various electric apparatus. He was 63 years of age.

Plymouth Electric Lighting.—The Plymouth Corporation have made public their intention to apply to the Board of Trade, on or before December 21st, for a provisional electric lighting order.

The Institution of Electrical Engineers.—On Thursday, November 23rd, 1893, there will be commenced the discussion on Prof. Geo. Forbes's paper on "The Electrical Transmission of Power from Niagara Falls."

Derby Electric Lighting.—The first installation of electric light in Derby is about to be supplemented by the addition of another engine, and the extension of the mains through one of the chief thoroughfares and to the Midland Railway station. The cost incurred already is about £30,000, and an additional £5,000 is to be expended. A Birmingham "daily" states that the large expenditure of money does not meet with universal approval in the town.

Electric Lighting of Bridges in India.—*Indian Engineering* states that 1892-93 was the first complete year that the "Hooghly" Calcutta-Howrah Bridge has been lighted by electricity, and it is observed that the actual expenditure has amounted to Rs. 12,386, against an estimate of Rs. 4,660. "No explanation of the heavy increase has been given. A detail of this expenditure should be supplied so as to show whether any abnormal expenses have helped to swell this charge."

Explosion at Glasgow.—Through the escape of gas into one of the electric light main boxes in Bath Street an explosion occurred on 9th inst., tearing up a considerable length of the footpath. No one was injured. Mr. Arnot, the Corporation's electrical engineer, writing on the subject, says:—"This was caused by a leakage from the gas mains, and ignited by a spark from punctured test wires which passed through the junction box. The electrical mains in the culvert were all cut off at the time. There was no current passing in the culvert when the explosion took place."

Electric Lighting in the Post Office.—The wiring of the New General Post Office building in Aldersgate Street is about to be commenced. The work will be done by the staff engaged at St. Martin's-le-Grand, and will not be put out to tender. It is estimated that about 2,000 lamps of 16 candle-power will be needed. The Brighton head post office, in Ship Street, and the telegraph rooms in the Norwich post office, have recently been equipped with the electric light. In the former case 195 lamps have been fixed, and the current is taken from the Corporation's mains, Messrs. Laing, Wharton & Down being the wiring contractors. In the latter the current is derived from the mains of the Norwich Electricity Company, and Messrs. Laurence, Scott & Co. were the wiring contractors. The new illuminant is much appreciated by the staff at both places. At the Glasgow head post office, at present lighted from the mains of the Corporation's electricity supply system, extensive additions to the building have been in hand, and are now nearly completed. In consequence of the additional accommodation, it has been decided to put down an independent generating plant to supply the office with light. Three Lancashire boilers are being made by Messrs. Penman & Co., of Glasgow, and Messrs. Willans & Robinson have orders for three Willans-Crompton steam dynamos of 80 horse-power to be installed for the purpose. The boilers will be fitted with Vicars's mechanical stokers, and the steam pipes, pumps and accessories will be supplied by Messrs. D. Stewart & Co., of Glasgow. In addition to the steam dynamos, there will be two horizontal engines, with suitable air and vacuum pumps fixed in the engine-room for the pneumatic tube service. It is anticipated that the plant will be running by March next.

The Alleged Harness Conspiracy.—Another Arrest.—Dudley Towers, a masseur, was charged at Marlborough Street yesterday with being concerned with the three prisoners, now under remand, in the alleged conspiracy to defraud. Evidence of the arrest having been given, the sworn information of Frederick Theobald Burbage, one of the four prosecutors, was read. The prisoner was remanded until next Wednesday, the magistrate offering to accept £100 as bail.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Exeter Electric Light Company, Limited.—The annual return of this company, as filed on the 12th ult., reveals the fact that out of a capital of 20,000, in £10 shares, 1,100 have been taken up, and the full amount paid on each. A sum of £7,950 has been received, and £3,050 has been agreed to be considered as paid.

Queen Anne's Mansions Lighting and Heating Company, Limited.—The annual return of this concern shows that £60,000, in 3,000 preference and 3,000 ordinary shares of £10 each, was the original capital. The whole of this has been taken up, and the full amounts have been paid.

The South Staffordshire Electric Lighting Company, Limited.—According to a document filed at Somerset House not long ago, it appears that this company has been wound up voluntarily, and that the proceedings attending the conduction of the liquidation were laid before a general meeting.

Sunbeam Lamp Company, Limited.—The last return of this company shows that out of a nominal capital of £25,000, in £10 shares, 1,595 shares have been taken up. There has been £10 called on each of 213 shares, and £1 on each of 525 shares. The total amount of calls received reaches £2,625, and £8,570 has been agreed to be considered as paid. A sum of £30 is still outstanding, and £11,430 has been surrendered on 1,143 shares.

Halifax and Bermudas Cable Company, Limited.—This company filed its return for 1893 on the 13th ult. From this document it appears that out of a capital of £50,000, in £5 shares, the whole capital has been taken up, and fully paid.

Madras Electric Tramways Company, Limited.—On October 31st last this company filed its annual return, which states that out of a capital of £100,000, in £1 shares, 78,792 shares have been taken up. On 14,427 of these, 10s. has been called, and on the 44,715, 9s. 4d. (or Rs. 7) has been applied for. The amount of calls received reaches £19,544 19s. 8d., and that agreed to be considered as paid £19,650. There is £8,535 10s. 4d. in arrear.

THE CHARGES AGAINST HARNESS AND HIS ASSISTANTS.

At the Marlborough Street Police Court, on Wednesday, Mr. Hannay resumed the hearing of the charges of conspiracy to defraud brought against Mr. Cornelius Bennett Harness, managing director of the Medical Battery Company, Limited; Mr. James Montgomery McCully, physician; and Charles Beavington Hollier, a salesman of the company. The charges were brought forward by Colonel Jeremiah Brayer and other persons, Mr. Thomas Terrell, appearing for all the prosecutors. Mr. Horace Avory appeared for Mr. Harness, Mr. A. R. Cluer for McCully, and Mr. C. F. Gill for Hollier.

Mr. TERRELL said he appeared to prosecute the prisoners for defrauding, firstly, the public generally, and secondly, each of the prosecutors individually. The prisoners were then each charged with a separate offence. Mr. Terrell proceeded to state that the misrepresentations were firstly by advertising Mr. Harness as skilled in electrical and medical knowledge, and able to cure various diseases by means of an electric belt. Mr. McCully represented that he was a qualified medical man, whereas some years ago he was struck off the register. The business of the Medical Battery Company was of a unique character. Enormous sums were spent on advertising; in one year as much as £50,000, the object being to induce persons to come into the premises. They were then led to suppose that one of the salesmen who usually received them was Harness, who, said Mr. Terrell, was the principal spirit of the enterprise. Hollier was a salesman, but represented himself on many occasions to be Harness. The wickedness of the system would become apparent when he exposed what the prisoners had done. They had no respect for either age, youth, suffering or poverty, but only wanted money. The learned counsel then quoted from a number of pamphlets and advertisements issued by Harness. He then traced the career of Harness, and, in conclusion, produced one of the belts and dealt with its construction.

A former clerk of the Medical Battery Company, named Williams, was called, and stated that Mr. Harness had the control of everything; Hollier was one of the consulting officers; McCully he only knew by name. Witness then described the fitting up of the premises and the method of treating clients.

WILLIAMS was severely cross-examined by Mr. AVORY and Mr. GILL, and admitted that he had been approached by solicitors in the action as to giving evidence, but he gave evidence without any feeling of irritation.

Mr. CLUER asked that McCully might be released on his own recognisances, in view of the evident intention of the prosecution to drag the case out. He was only referred to in one of the four charges, but had been in custody all the week on account of the amount of bail required.

Mr. HANNAY reduced the bail to two sureties of £100 each.

The hearing was then adjourned until next Wednesday.

CONTRACTS OPEN.

Douglas (Isle of Man).—November 25th. For the extension to Laxey of the existing line from Douglas to Groudle Glen, for the Douglas and Laxey Coast Electric Tramway Company. The works to be tendered for are in two sections, numbered 2 and 3. Section No. 2 comprises a roadway 2,200 yards in length and about 40 feet wide, and laying a 3 feet gauge railway line on one side. It also includes a masonry bridge 50 feet high, with three 20 feet spans, and a culvert 100 feet long, 7 feet span, and 13 feet high. No. 3 comprises the formation and laying of a railway line, 3 feet gauge and about 6,000 yards long. Rails, sleepers, fastenings, electric plant, and rolling stock are not included. Plans, &c., can be seen at the office of Mr. F. Saunderson, C.E., Athol Street, Douglas, Isle of Man.

Dublin.—December 14th. For the extension of the buildings and the supply and erection of additional plant at their central station, Fleet Street, Dublin, for the Corporation of Dublin. Plans may be seen, and specifications and forms of tender obtained, at the office of Mr. Spencer Harty, C.E., city surveyor, City Hall, Dublin.

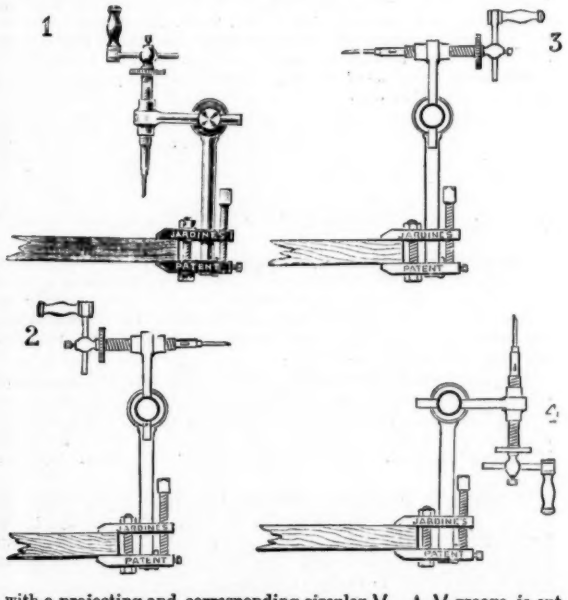
BUSINESS NOTICES, &c.

The Universal Electrical Directory (J. A. Berly's), now under the direct supervision of the proprietors, H. Alabaster, Gatehouse & Co., is in active preparation for the 1894 edition (13th year). This is a directory of the electrical trades embracing the whole Universe, and having no superfluous matter irrelevant to a directory it can be sent everywhere, carriage paid, for 4s. It is indispensable to all having business transactions in the electrical world, and once used cannot be done without. Advertise in it! Order it! It will prove the best outlay ever made.

Chichester Electric Lighting.—The following report has been made by Councillor Prior to the sub-committee of the Lighting Committee of the Chichester City Council:—"I have consulted an electrical engineer upon the probable cost of lighting the city by electricity. As you will remember, the idea was not to get a detailed report and prepare a scheme, but more especially to get an estimate of the probable cost, so that the committee might have some guide as to the advisability or otherwise of having a definite scheme prepared, with a view to adopting electricity for our public lighting instead of gas. The engineer visited the city on two occasions and went fully into the matter, and has sent a report and a good deal of information upon the subject. The conclusions he arrived at, in short, were these: That the initial cost of lighting the principal streets of the old city with electricity would be from £12,500, as a low estimate, to £14,000 as a very high one, made up as follows:—Buildings, £2,000 to £2,500; boilers, £1,000; steam-piping, pumps, &c., £500; engines and dynamos, £2,000 to £3,000; storage batteries, £400; distributing mains, £3,500; street opening and conducts, £1,700; arc lamps and standards, £600; switchboards and instruments, £300; contingencies, law, consulting and supervision, £500; = £12,500. In estimating the cost of the buildings, the stores on the banks of the canal were thought an extremely advantageous position for a central station using steam power, where sufficient ground for the erection of the requisite buildings is already the property of the Corporation. This is only distant about half-a-mile from the centre of the city, and the canal would afford sufficient water for condensing purposes, thus effecting a considerable saving on coals. The annual expenditure will be about as below; the repayment is based upon the supposition that the Local Government Board would grant 30 years for the repayment of principal:—Yearly

expenditure.—Coals, say £500; chief engineer, £200; assistant, £120; two engine drivers, £180; two cleaners, £120; two stokers, £150; lamp trimmer and linesman, £80; clerk and storekeeper, £80; three labourers, £150; carbon, oil, and stores, £150; depreciation and repairs, &c., £300; = £2,030. To this must be added annual repayment and interest for 30 years (on £14,000), £751; = £2,791 total. The revenue should be as under, but this, of course, is a very rough estimate, as it is impossible to say exactly how many tradesmen and others would use electricity for private use, and it would greatly depend upon what enterprising spirit would be shown by the tradesmen, whether the estimate would prove a low or a high one, but the engineer consulted assures me he believes, in three years, his estimate would be found a very low one. It will also be observed the suggestion is not to interfere with the present mode of lighting the back streets of the old borough with gas for a time. Revenue estimate: Sale of 90,000 units at 8d., £3,000; to add, saved on the public lighting by gas, £300, = £3,300. It will be seen that if these estimates prove accurate, not only should we be able to repay principal and interest and at the end of 30 years the undertaking would be unfettered, but, during nearly the whole period we should be earning an annual sum of £500 for the ratepayers in shape of surplus revenue over expenses. The electric lighting could also be carried to the new district, and slightly increase the profit to the corporation, for the extra initial cost of including those districts would be comparatively inconsiderable. Fifty lamp-posts fixed at £4, £200; cables (lead covered Silvertown), £500; opening ground, &c., £150; = £910, say, with supervision, &c, £1,000. Extra annual expenditure:—Extra coal, £46 2s. 6d.; lamp renewals, £37 10s. 0d.; = £83 12s. 6d.; to this should be added interest and principal repayment, 3½ per cent. and 30 years, £55; = £138 12s. 6d. So if we allow for no extra revenue for private lighting for the extended district, it would still be cheaper than gas, for it would average £2 15s. per lamp as against £3 17s. per gas lamp as per present contract, and a very great deal better light than gas would give."

Jardine's Improved Portable Drilling Machine.—The difficulty hitherto experienced in universal hand drilling machines is that of easily, and yet securely, fastening the radial arm (carrying the drill stock), at any angle and in any required position. Mr. John Jardine, of Nottingham, is now introducing a machine in which he overcomes this difficulty by making on the top part of the pedestal or column, which carries the radial arm, a disc in which is made a circular V groove and to which is fitted a second loose disc made



with a projecting and corresponding circular V. A V-groove is cut across the face of the loose disc to receive the radial arm. Through the centre of both discs an eyebolt is passed, the eye of which passes the radial arm. The part of the eyebolt projecting through the disc on the pedestal is tapped and fitted with a nut which, when drawn up with a moderate pressure, securely fastens together the pedestal disc, the loose or movable disc, and the radial arm, so that the danger of this arm (which carries the drill stock), shifting or slipping whilst at work is removed.

The Halifax Mutual Electric Light and Power Company, Limited.—At an extraordinary general meeting of the above-named company, held at the offices of Thomas England, solicitor, Townhall Chambers, Halifax, on October 14th, the following special resolution was duly passed; and at a subsequent extraordinary general meeting, held at the same place, on November 4th, the resolution was duly confirmed:—"That the company be wound up voluntarily under the provisions of the Companies Acts, 1862 to 1890." William Dearnley Taylor, of Halifax, was appointed liquidator for the purposes of the winding up. Creditors of the company are required, on or before December 16th, 1893, to send their names and addresses, and the particulars of their debts or claims, and the names and addresses of their solicitors (if any), to the liquidator as above.

Huddersfield Electric Lighting.—A report to the Borough Council *re* electric lighting at Huddersfield, reads as follows:—"The electric lighting station was officially opened, and the supply of energy commenced on July 29th. The number of consumers then connected was 33, or equivalent to 2,200 8-candle-power lamps. The number of consumers now connected is 84, equivalent to 6,800 8-candle-power lamps, and many more premises are being fitted up, and will immediately require connecting with the supply mains. It has been found necessary to extend the mains up New North Road, to the Edgerton district to supply several of the residents, and already 18 consumers have been arranged, and the supply of energy will be commenced in about a fortnight, when it is expected that a large number of residents will adopt the light. The total length of conduit laid for high tension mains is 12,000 yards, into which 5,420 yards of cable have been drawn. The total length of low tension mains laid is 5,305 yards. The number of junction boxes fixed is 127. The generating plant at the electric supply station is being increased by the addition of one engine and alternator, capable of supplying 6,600 8-candle-power lamps, which, with the existing machinery, will be ample to meet all demands during the coming winter. The electric light has been installed in the following corporation departments, viz.:—The Town Hall and Municipal Offices, the Market Hall and Tramways Office, and the Sewage Works also has the electric light, but it is supplied by its own generating plant. The telephone exchange for connecting the whole of the corporation departments together, is nearly completed, and has already proved of great service.

Newport Electric Lighting.—At a recent meeting of the Town Council Mr. Cordey asked whether the sub-committee who brought up a report dealing with electric lighting, had considered whether the cables could be laid through the sewers, as was done, he understood, in Australia. Mr. Williamson said that at this time of day no engineers would recommend steam power to be used for electric lighting purposes, and asked why the Severn Tunnel water was not utilised for the purpose. Mr. W. F. Phillips asked why a plan or specifications had not been prepared for firms tendering for the electric lighting plant. Alderman Moses replied that the reason was to give local firms an opportunity of tendering for portions of the plant. The idea of utilising the sewers for the cables was ridiculous. The sub-committee had taken the best advice they could as to the power to be used, and were advised that steam was the best for the present. If water were resorted to, it would not be necessary to get water from the Severn Tunnel; the ebb and flow of the Usk would be available. He twitted gentlemen with ignoring things until the time had passed, and then rushing suggestions on the council. The report of the committee inviting tenders was then adopted.

To Whom does this Refer?—The *Staffordshire Advertiser* understands "that some extensive engineering and electric works are to be erected at Wolverhampton, in which several capitalists and gentlemen connected with this county will be interested. Last week the Town Council sanctioned an application for the rails from the Midland goods station to be laid across the Wednesfield Road to land on the opposite side of the road, which will be the site of the proposed works, and a railway siding will be provided. The site consists of between three and four acres of vacant land, which is level, and will form a suitable position. The works will be adjacent not only to the Midland goods depôt but in close proximity to the main line of the Great Western Railway Company. At present the gentlemen associated with the scheme are reluctant to divulge the details, as also are the Corporation, but the latter have been assured that the works will be of an extensive character, and materially add to the value of the property and prestige of the town. The only works of the kind in the neighbourhood are those of the Electric Construction Corporation at Bushbury, outside the borough boundary."

Provisional Orders.—The *London Gazette* contains several notices of applications which are to be made to Parliament and the Board of Trade for electric lighting provisional orders as follows:—

Oswestry Electric Lighting and Power Company: supply of electricity for both public and private purposes in the borough of Oswestry.

Shropshire Electric Light and Power Company: supply of electricity for public and private purposes in the borough of Shrewsbury.

Leyton Local Board: supply of electricity for public and private purposes within the district of Leyton, and to manufacture, hire, sell, and let electric apparatus.

Aberdare: application by J. C. Howell, of 24, Queen Victoria Street, London, for power to supply electricity for public and private purposes within a certain portion of the area under the jurisdiction of the Aberdare Local Board.

Camberwell Vestry: power to supply electricity within the parish of Camberwell.

Electricity in Mining.—Messrs. Ernest Scott & Mountain, Limited, electrical and general engineers, Newcastle, have received an order from the Coltness Iron Company, Newmains, Lanarkshire, for an electric light installation for their colliery, which will be one of the most complete plants in existence. The plant consists of a complete electric light installation for the colliery consisting of a dynamo to run 200 16-C.P. lamps and about 180 lamps throughout the pit, both above ground and underground. The second is an installation for the lighting of 34 workmen's cottages, which are about 700 yards from the colliery, there being 3 lights placed in each cottage, or a total of 102 lamps in all. The third installation consists of a complete electric pumping plant capable of delivering 100 gallons of water per minute from the river to the colliery.

Catalogues, Price Lists, &c.—A useful price list has been brought out by Messrs. W. T. Henley's Telegraph Works Company, Limited, dealing with electric light cables and wires, insulated with vulcanised and unvulcanised India-rubber, twin flexible electric light cords, wood casings, jointing materials, &c. Great pains have been taken with the preparation of the detailed particulars which are given in tabular form, so that prices of the various classes and dimensions of wires can be found with very little trouble. Some simple instructions for jointing are given at the commencement of the book, and there is also a spare list giving the insulation resistances of cables. The catalogue, which consists of about 20 pages, should be of great use to Messrs. Henley's customers. It is printed very neatly on excellent paper, and, on the whole, is a very good production.

The "Sunbeam" Lamp Company, of Gateshead, have sent us one of their illustrated catalogues dealing with the "Sunbeam" incandescent lamps and fittings. Lamps of from 8 to 50 C.P. are quoted at 1s. 6d. to 2s. each. Page 9 sets forth in tabular style the current required for sunbeam lamps. Lampholders and opal and enamelled iron shades also take up space in the pamphlet, which is a neat little book.

Cost of Electric Lighting with "Robertson" Lamps.—The General Electric Company have published a table showing the total cost of electric lighting when using "Robertson" lamps of 16 candle-power at various efficiencies in watts per candle-power. This should be of interest to contractors and users of electric lighting. The table is calculated on the basis that a 4 or 3½ watt lamp costs 1s. 6d. The cost of renewals is based on experience gained by practical working with the "Robertson" lamps. In this table all lamps are considered as renewable when they have lost 25 per cent. of their original candle-power. The General Electric Company guarantee that the "Robertson" lamps will not take more current on an average, during their "efficient life," than the values reckoned for cost of current.

Hackney Electric Lighting.—At last week's meeting of the Hackney District Board, the order of the Board of Trade for the electric lighting of Hackney was considered. This order is to authorise the Board of Works "to produce, store, distribute, and supply and let on lease or sell electricity for all or any of the public and private purposes as defined by the Electric Lighting Acts, 1882 and 1888." The undertakers are required within two years to lay sufficient distributing mains for general supply throughout High Street, Kingsland; High Street, Stoke Newington; Kingsland Road, Mare Street, Stoke Newington Road and Dalston Lane. The Electric Lighting Committee intend to push forward the matter as soon as possible.

Sykes's Improved Fuel Economiser Company, Limited.—The *London Gazette* publishes notification to the effect that creditors of the above company are required, on or before December 18th, 1893, to send their names and addresses, and the particulars of their debts or claims, to John Joseph Graham, of 77, King Street, Manchester, chartered accountant, the liquidator of the company, and, if so required, by notice in writing from the said liquidator, are, by their solicitors or personally, to come in and prove their said debts or claims at 77, King Street, Manchester, at such time as shall be specified in such notice, or in default thereof they will be excluded from the benefit of any distribution made before such debts are proved.

The General Electric Power and Traction Company, Limited v. Sargeant.—In the City of London Court last week, £2 was claimed by the plaintiffs, of Queen Street Chambers, against the defendant, Mr. W. S. Sargeant, of Twickenham, for charging an electric launch to his alleged order. The plaintiffs' case was that they charged the defendants' launch, *Florentia*, with electricity to the order of the defendants' servants. The defendant said that he never gave the plaintiffs any order to charge the launch with electricity. The defendant was called as a witness for the plaintiff, and he then stated that he had given his servants no authority to give an order. He gave all orders on a printed form. Judgment for the defendant, with costs.

Electricity in Mining.—The Moodie Gold Mining and Exploration Company, of South Africa, have now concluded contracts with Messrs. W. T. Goolden & Co., of Woodfield Works, Harrow Road, London, W., for the supply and erection of plant for the electrical transmission of 250 H.P. generated by water-power of the Queen's River, to the various mines situated near Barberton, a distance of about 10 miles. This is the most important power transmission scheme yet undertaken in South Africa, and if successfully carried out must have an important bearing on the future of some of the South African gold fields.

Guildford Electric Lighting.—Notice having been given to the Town Council by the Holloway Electricity Supply Company, Limited, of its intention to apply for a provisional order to supply electricity in Guildford, a preliminary meeting of tradesmen and others was held last week, the following resolution was passed: "That this meeting is in favour of the introduction of electric lighting into Guildford, and for the purpose of furthering the matter the meeting be adjourned until Monday, 13th inst."

Electric Light at Richmond.—Mr. C. A. Hemingway, of Richmond, is carrying out an installation in the premises of Mr. John Cockburn, jeweller, &c., George Street, Richmond, where 60 lamps of 16 candle-power are being fitted. Mr. Hemingway has also carried out installations at the premises of Mr. T. J. Palmer, chemist, Mr. G. H. Young, wine merchant, Mr. Arthur Greeves, hatter, &c., all of George Street. Mr. Young's was said to be the first shop in Richmond to be lighted by the electric light.

Chagford Electric Lighting.—A vestry meeting was held last week to vote an account for lighting the streets during the year ensuing, and to appoint an inspector in the place of the retiring member. As it was generally understood that both the promoters of the gas works and electric works were desirous of being favoured with the order of lighting the streets, there was a large number of ratepayers present. Mr. W. Lyddon, who is favourable to continue the lighting of the town with electricity, was elected inspector by a large majority. The town will, therefore, continue to be lit by electricity.

A Good Resolution.—At a large meeting of the inhabitants of Poole, Parkstone, and Bournemouth, the following resolution was passed:—"That this meeting of inhabitants of Poole, Parkstone, Bournemouth and district, pledges itself to do everything in its power, both financially and otherwise, to facilitate the carrying through of the scheme for laying down electric tramways between Poole and Bournemouth, and the electric lighting of the town and district of Poole."

Omnibus Electric Lighting.—The *Financial News* states that the prospectus of the Omnibus and Tram Car Electric Lighting Company, Limited, will appear in a few days. The company has received numerous applications for lighting vehicles, &c., and the carriage of the Lord Mayor has recently been fitted up by them. Arrangements have also been made with various omnibus and tramway companies for the lighting of their cars upon this system.

The Eclipse Electric Lighting Syndicate, Limited.—A general meeting of the members of the above company is to be held at 8, Finsbury Circus, E.C., on December 20th, 1893, at eleven o'clock, for the purpose of having an account laid before them showing the manner in which the winding up has been conducted, and the property of the company disposed of, and of hearing any explanation that may be given by the liquidators.

Electric Lighting at Bristol.—Mr. Uriah Alsop's cabinet works in Broadmead are being fitted with the electric light by Messrs. King, Mendham & Co., of Bristol. The whole of the showrooms and windows will be lighted by incandescent lamps, representing nearly 3,000 candle-power. The contractors furnish the whole of the generating plant, including the dynamo and all the necessary switchboards and fittings.

The Corlett Electrical Engineering Company, Limited.—This company have opened a branch office at the above address under the management of Mr. C. W. Fairweather, who for the past few years has been works manager for Messrs. Ernest Scott and Mountain, Limited, Newcastle-on-Tyne. We have received a list of the installations of electric lighting and pumping carried out by the Corlett Company.

Dover Electric Lighting.—The question of lighting the streets of Dover by electricity has, at length, been finally settled by the Town Council. A large amount of correspondence with regard to the lighting scheme, has been going on between the Brush Electric Lighting Company, but the agreements have now been approved. A local company is to be formed and prospectuses will be issued very shortly.

Electro-Deposition of Copper.—The *Western Mail* says it is stated that a proposal is on foot, and is being discussed by some of the leading capitalists of the Swansea district, to establish in the neighbourhood of Landore large new works for the electrical deposition of copper and other metals. Nothing has yet been definitely decided upon, however.

Lyons Exhibition, 1894.—The Executive Committee of the Exposition Universelle, Internationale et Coloniale en 1894 at Lyons, has appointed Mr. Brandrethas, of the Anglo-Continental Contract Association, Limited, their authorised agent for Great Britain and Ireland. Those desirous of exhibiting should apply to him.

Auction Sale.—To-day Messrs. Wheatley Kirk, Price and Goulty will offer for sale by auction on the work's premises, in one lot, the freehold land and buildings, motive power, &c., of the modern engineering and boiler-making fixed and loose plant of the Vulcan Iron Works Company, Beccles, Suffolk.

Circus Lighting.—At the new Royal Circus opened by Messrs. Sangers, on Monday, at Birmingham, both gas and electricity will be employed for lighting purposes. Several large arc lights have been supplied by the Walsall Electrical Company, Limited, for use inside and outside the building.

Phosphor Bronze Company.—This company have appointed Messrs. Dempster Moore & Co., of 49, Robertson Street, Glasgow, to be their sole agents in Scotland, for the sale of their various manufactures. They will keep a small stock of some of the metals there.

Coatbridge Electric Lighting.—It is expected that the House-to-House Electricity Company will have their works and arrangements so far completed by the end of the present month that they will be able then to supply their customers in Coatbridge with current.

Oystermouth and Electric Lighting.—The Oystermouth Local Board of Health have requested their engineer, Mr. John Stansfield Brun, C.E., of Mumbles, to prepare and submit to them a report upon the proposed electric lighting of the town.

Electric Light at Hull.—The Royal Institution is being fitted up with the electric light.

Awards.—The Commercial Cable Company have secured the only two awards issued by the World's Fair Committee for improved apparatus and system of working submarine cables.

Electric Light at Cork.—Three powerful electric arc lamps have been introduced by Messrs. Newsom & Sons, Patrick Street, Cork, for the lighting of the frontage of their grocery establishment.

CITY NOTES.

Electric Construction Company, Limited.

THE statutory meeting of this company, under the organisation scheme, was held at Cannon Street Hotel, yesterday; afterwards the meeting was resolved into an extraordinary one for the purpose of making alterations in the articles of association. The proceedings were of a formal character.

West India and Panama Telegraph Company.

THE thirty-third ordinary general meeting of the members of this company was held on Wednesday, at Winchester House.

The CHAIRMAN (Mr. C. W. Earle), in moving the adoption of the report, made a feeling reference to the death of his colleague, Mr. Henry Weaver, who was elected to a seat on the Board by a committee of shareholders, nearly 20 years ago, and stated that the vacancy had been filled by the appointment of Mr. G. W. Balfour, M.P. He thought they might congratulate themselves on having had, for a West Indian Company, rather a satisfactory half-year. The normal traffic increased somewhat from the great reduction that occurred owing to the reduced rates forced upon the company in the year 1891. In consequence of the breakdown of the cable of their competitor, the French Cable Company, the whole traffic of that line came upon this company's line at Martinique, and during the seven weeks they were interrupted they had an increase in traffic of about £2,800. The expenses of repairs to cable amounted to £10,520, being £12,358 less than those for the corresponding period. This decrease was due to fewer repairs and to the smaller quantity of cable used. The directors, desiring to recognise the long and faithful services of some of the employés, and to strengthen the good relations which existed between the company and its staff, proposed to offer to bear one-half the expenses of life or endowment insurances for some of those who had been in the company's service a certain number of years. He could not say what the expense would be, but the saving effected by not filling up two vacancies on the board would leave a good margin. The board proposed to pay dividends of 6s. per share on the first and second preference shares respectively, and 1s. per share on the ordinary.

Mr. W. ANDREWS seconded the resolution.

Mr. KING expressed the hope that Mr. G. W. Balfour, the new director, had no connection with that atrocious individual named Jabez Balfour.

The CHAIRMAN explained that the new director was a brother of Mr. A. J. Balfour, the leader of the Opposition in the House of Commons, and had no connection whatever with Jabez Balfour.

The resolution was then carried unanimously.

The Western and Brazilian Telegraph Company, Limited.

THE directors' report, to which we referred last week, reads as follows:—

"The directors submit their report and the accounts of the company for the half-year ended June 30th, 1893. The total earnings amount to £79,373 10s. 4d., as against £84,021 16s. 9d., a decrease of £4,648 6s. 5d., compared with the half-year to June 30th, 1892. The working expenses amount to £43,424 1s. 3d., as against £39,140 16s 8d., an increase of £4,283 4s. 7d. The above comparisons are made, as usual, with the corresponding period of the preceding year, but the expenses for the two periods necessarily differ, because of the extra staff and arrangements required to work efficiently the duplicated and duplexed line, completed in 1892. At the meetings held in November, 1892, and May last, the chairman pointed out that the duplicated and duplexed cable would have to be worked to the best advantage to enable the company to hold its own with the traffic. The expenses, therefore, for the past half-year, under Abstract 'A,' should be compared with those of the half-year ending December, 1892, when the additional circuits were being manned and worked, and it will be seen that as regards the main items, notably 'salaries in Brazil,' no real increase occurs, the amount under this head being almost identical. Following upon the measures taken, the volume of traffic has increased 12½ per cent., which is satisfactory. Notwithstanding, however, the substantial increase in the number of words carried, the revenue derived, owing to various causes, unavoidable alterations in tariff, changes in locality of traffic, and so on, shows the reduction already pointed out in paragraph 2. The shareholders were also informed as to the arrangements for the ultimate employment of one ship instead of two, as heretofore. The half-year under review was a transition period, during which the two former vessels and the new substitute were necessarily all three in commission, two on the coast and for a time coming home, and the new ship on her way out. The *Norseman* No. 1, and the *Viking* have now been laid up, pending sale or employment, and the directors are glad to say that the policy of the board has so far been successful, both as to the value of the new steamer in the matter of speed during the present critical time in Brazil (where she has just rendered special and important service), and as to future expenses. The economy insured under this head will become apparent in the accounts for the current half-year. Including the amount brought forward from 1892 (£2,829 15s. 6d.), the balance to the credit of the revenue account is £38,779 4s. 7d., from which has to be deducted £12,093 for debenture interest, and £7,007 for the debenture redemption fund, leaving £19,679 4s. 7d., of which £12,000 has been placed to the reserve fund. This leaves £7,679 4s. 7d. to be carried forward. The shareholders are aware of the exceptional state of affairs in Brazil, and the great uncertainty as to what the outcome may be. Under these circumstances the board are unable to recommend a dividend at this time. With the restoration of tranquility, and an adequate increase in exchange consequent upon it, coupled with the improvements effected in the company's arrangements, the financial position would be again satisfactory. The directors have to notify that the conversion of ordinary shares into preferred ordinary and deferred ordinary shares (after January 1st, 1894) will be suspended."

The twenty-sixth ordinary general meeting of this company was held yesterday, at Winchester House, under the presidency of Mr. W. S. Andrews.

In moving the adoption of the report,

The CHAIRMAN first dealt with the receipts, which amounted to £79,373 10s. 4d., compared with £84,021 16s. 9d., showing a decrease of £4,643 6s. 5d. The expenses had increased by £4,283 4s. 7d. On the face of it, it appeared an unsatisfactory thing that there was a decrease in revenue and an increase in expenses. That, however, after all said and done, really pointed, in one respect, to a very satisfactory position of the affairs, and to a considerable improvement in the stability of the company, for reasons which he explained to them. In regard to the ships, they were compelled to have, for a time, three ships on the station, in order, ultimately, to be able to manage with only one. There was an increase in the *Norseman's* expenses as well as in the cost of her coals. There was an increase on the *Viking*, because during the corresponding period she was out of commission for a considerable period, which made £1,735. On the coals of the *Viking* there was an increase. Then there was the item of the new ship, including fitting up and other expenses. The London expenses showed a saving of £230 odd. That was satisfactory, as shareholders always looked very narrowly at that account. Some time ago they resolved to lay looped cables; that was to avoid interruptions, to keep the traffic together by the non-occurrence of interruptions, and to enable them to manage with one ship. As was shown in the report, those objects had been secured. Since the cables were completed between Pernambuco and the River Plate, not a single total interruption had occurred. After commenting further upon this subject and its effect in fighting competitors, he stated that with all their competition they had actually carried 12½ per cent. more words, but that increase of words had left less money under the competitive rates. He next referred in much detail to the state of affairs in Brazil and South America generally. Message work was entirely suspended on the company's lines by the government from September 6th to 18th. That suspension was then withdrawn with respect to messages in plain words, but merchants were not to be expected to depart from their old established code systems of telegraphing. Great credit, and the expression of satisfaction and approval by the meeting, was deserved by the staff at Brazil who had stuck to their posts until the last, amid revolution and firing. One of their porters had even been killed by a stray shot. After further remarks the Chairman moved the adoption of the report and accounts.

Mr. C. W. EARLE seconded.

Several shareholders suggested amendments, such as "that the report be not accepted," "that a dividend be paid of 3s. per share, and £5,000 carried forward;" but these were all declared out of order.

The meeting assumed a very noisy character, several shareholders desiring to get rid of the managing director (Major Wood), who, although he was a very competent man, carried off £1,800 a year. Major Wood kept silence as long as he could, but when the matter appeared to be dying out through the explanation offered by other directors, he asked permission to defend himself, which he did in a most able manner, ending his remarks, which were very warmly and indignantly made, with "You can't remove me, gentlemen; you may want to, but you can't; eight years of my agreement are yet unexpired; you can't, gentlemen." The meeting was thus decidedly turned in his favour, and shareholders could not refrain from saying "Well done!" There was also some smart fencing as to the amount of the directors' holdings, most of which were said to be small, but reference to the articles of association showed that the directors all held the necessary qualification, if not more, *i.e.*, 25 £5 shares.

The resolution being put to the meeting, it was carried by an overwhelming majority, only about twelve shareholders voting against it A cordial vote of thanks to the chairman was passed unanimously.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending November 12th, 1893, amounted to £909; week ending November 6th, 1892, £945; decrease £36: total receipts for half-year, 1893, £15,546; corresponding period, 1892, £15,345; increase £201.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 10th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,516.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation November 8th.	Closing Quotation, November 15th.	Business done during week ended November 15th, 1893. Highest.	Lowest.
184,500£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 – 103	...	...
1,134,640£	Anglo-American Telegraph, Limited	Stock	45 — 47	45 — 47	45⅛	...
2,932,680£	Do. do. 6 p. c. Preferred	Stock	84 — 85	85 — 86	85⅛	84⅜
2,932,680£	Do. do. Deferred	Stock	7⅜ — 8¼	7⅜ — 8¼	8	...
130,000	Brazilian Submarine Telegraph, Limited	10	11¾ — 12¼	11¾ — 12¼	12 3/16	12⅛
18,700£	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	107 —111	107 —111	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅝ — 3	2⅝ — 3	2 15/16	2⅝
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2⅛ — 2⅜	2⅜	2¼
125,000£	Do. do. 4½ per cent. Debenture Stock	Stock	106 —108	106 —108	...	...
20,510	Charing Cross & Strand Electricity Supply Nos. 1 to 6, 215 to 718, and 10,001 to 30,000	5	4⅜ — 5¼	4⅜ — 5¼	...	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	2 — 3	2 — 3	...	...
630,000£	City and South London Railway	Stock	28 — 33	28 — 33	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11¼ — 11⅜	11¼ — 11⅜	11⅜	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12¾ — 13¼	12⅜ — 13¼	13⅛	12⅜
10,000,000$	Commercial Cable, Capital Stock	$100	140 —150	140 —150	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	10/-	1/16 — 3/16	1/16 — 3/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	4 — 4¼	4¼ — 4⅜	4 7/16	...
50,000£	Do. do. 5 p. c. 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	96 —101	96 —101	...	...
16,000	Cuba Telegraph, Limited	10	11½ — 12½	11½ — 12½	12 1/16	...
6,000	Do. do. 10 p. c. Preference	10	18 — 19	18 — 19	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ — 3½	2½ — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	8½ — 9½	8½ — 9½	8½	...
60,710	Direct United States Cable, Limited. 1877	20	11⅛ — 11⅜	11⅛ — 11⅜	11⅜	11 3/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14¾ — 15	14¾ — 15	14 15/16	14¾
70,000	Do. 6 p. c. Preference	10	15½ — 16½	15½ — 16½	15 15/16	15¾
105,900£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,294,100£	Do. 4 p. c. Mortgage Debenture Stock	Stock	113 —116 xd	113 —116	114¼	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15⅛ — 15⅜	15¼	15⅛
62,700£	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	103½	102⅜
222,800£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	...	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	113 —116	113 —116	113¾	...
108,700£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	101 —104	102½	...
146,800£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	101 —104	...	...
300,000£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104	101 —104	...	...
200,000£	Do. 4 p. c. Reg. Mt. Debs. (Mauritius Subsidy) 1 to 8,000	25	103 —106 %	104 —107 %	106	...
49,900	Electric Construction, Limited, Nos. 101 to 45,100	10	1⅜ — 2¼	1⅜ — 2¼	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	⅛ — ¼	⅛ — ¼	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	⅛ — ⅜	⅛ — ⅜	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	⅛ — ⅜	⅛ — ⅜	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	¼ — 1½	¼ — 1½	...	...
180,227	Globe Telegraph and Trust, Limited	10	8½ — 8⅝	8¼ — 8½	8⅝	8¼
180,042	Do. do. 6 p. c. Preference	10	14⅜ — 15	14⅜ — 15½	15½	14⅜
150,000	Great Northern Tel. Company of Copenhagen	10	20 — 20½	20 — 20½	20½	20 1/16
200,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	103 —106	103 —106	...	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5½	4½ — 5½	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6 — 7	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½ — 22½	21 — 22	21⅜	...
200,000£	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	40 — 43 xd	40 — 43	40⅛	40
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	1 — 2	1 — 2	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4½ — 4¾	4½ — 4¾	4 7/16	4 1/16
15,000	Do. do. fully paid	5	6 3/16 — 6 7/16	6¼ — 6⅜	6⅜	5⅝
37,500	Liverpool Overhead Railway Ordinary, fully paid	10	5½ — 5⅝	5¼ — 5⅜	8¼	4⅜
6,295	Do. do. Pref., £6 paid	10	6 1/16 — 6 3/16	6⅛ — 6¼	6⅛	...
37,548	London Platino-Brasilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000£	Do. do. 6 p. c. Debentures	100	105 —108	105 —108	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	7½ — 8	7¼ — 7⅜	8	7½
50,000£	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	104 —107	106 —109	108	106¼
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	1½ — 2½	1½ — 2½	...	...
28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	3 — 4	3 — 4	...	...
484,597	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜ — 5	4⅜ — 5	4⅞	4 13/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	13½ — 14½	14 — 15	14⅝	14¼
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13½ — 14½	13½ — 14½	...	...
119,234	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5¼ — 5½	5¼ — 5½	5½	5⅜
726,477£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	113 —115	113 —115	114½	113½
48,800	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,452	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16 — 5/16	3/16 — 5/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	102 —105	102 —105	...	...
11,802	Reuter's Limited	8	5½ — 6½	5½ — 6½	...	...
19,930	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	6 — 6½	6 — 6½	6½	6 1/16
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	8 — 8½	8 7/16	8 3/16
3,381	Submarine Cables Trust	Cert.	113 —118	113 —118	...	...
78,942	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	2 — 2½	2 — 2½	2⅜	2 1/16
37,350	Telegraph Construction and Maintenance, Limited	12	33 — 35	34 — 36	35⅛	34
150,000£	Do do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	2 — 2½	2 — 2½	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	90 —100	90 — 100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½ — 6½	5½ — 6½	...	...
260,900£	Do. do. do. 5 p. c. Debentures	100	98 —101	98 —101	99	...
30,000	West Coast of America Telegraph, Limited	10	2 — 3	2 — 3	...	...
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	99 —103	99 —103	101½	101¼
€4,242	Western and Brazilian Telegraph, Limited	15	5½ — 6½	5½ — 6½	5⅝	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5½ — 5⅝	5½ — 5⅝	5 5/16	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1 — 1⅛	1 — 1⅛	...	...
178,200£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
222,700£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅛ — 1⅜	1⅛ — 1⅜	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	10	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9 — 10	9 —10	...	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	107 —110	107 —110	...	...
$1,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	113 —118 xd	113 —118	...	...
169,000£	Do. do. 6 p. c. Sterling Bonds	100	102 —105	102 —105	...	...
69,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5½ — 6	5½ — 6	5 5/16	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅛—6⅛.—Brush Company, 4½ per cent. Debenture Stock, issued at 1 per cent. premium, 107—109.—Electric Construction Corporation 6 per cent. Debentures, 87—92.—Electric and General Investment, shares of £5 (£1 paid), 1½—2½.—Founders' shares, 200—225.—Electricity Supply Corporation, Ordinary of £5, 5—5⅛.—House to House Company (£5 paid) 1—2.—Do. 7 per cent. Preference of £5, 4⅜—5⅛.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited. Ordinary Shares £5 (fully paid), 4⅞—5⅛, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6¼—7.—Liverpool Electric Supply, £5 (fully paid) 6⅜—6⅝.—Do. £3 10s. paid, 4⅜—4⅝.—London Electric Supply Corporation. £5 Ordinary, ⅞—1⅛.—Manchester, Edison and Swan Company £5 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating 6 per cent. £100 Debentures, 101—103.

Bank rate of discount 3 per cent. (October 5th, 1893.)

THE PRIMARY ACTION OF THE GALVANIC CURRENT.

BY J. MOUNT BLEYER, M.D., and M. MILTON WEILL, M.D.

WE are indebted to the authors for advance sheets of this paper, which was read before the American Electro-Therapeutical Association, Chicago, September 12th, 1893.

Schönbein, in drawing his conclusions regarding the nature of ozone, assumed that oxygen was capable of three distinct conditions, viz.: ozone, electro-negative, antozone, electro-positive, and neutral oxygen, which, as its name indicates, has no polar distinction, but could be polarised and depolarised at will.

Of these three so-called forms of oxygen, the investigations of the observers since the day of the great Basle chemist have much changed our views. To-day we admit the existence of only two forms of oxygen—ozone and neutral oxygen, and for the sake of elucidation we give you the graphic construction of the molecule as we believe it to be:

$\overset{-}{O}\overset{+}{O}\overset{-}{O}$ = Ozone.

$\overset{-}{O}\overset{+}{O}$ = Neutral oxygen.

Assuming, as he and the aftercoming observers did, that oxygen in its free state was neutral, and it so proved to be, he reasoned and it is within the pale of all researches, even up to our own time, that as soon, or rather as we have found it, just before this oxygen enters into combination with either organic or inorganic substances in the presence of moisture it becomes polarised.

Carrying these conclusions into the field of physiological chemistry, he became convinced that the corpuscles like phosphorus were possessed of the power of polarising the oxygen in the lungs, and further of splitting up the molecules and re-arranging them in the form of ozone. His idea was that ozone existed in the blood, that it was the vital oxidising agent by means of which the recuperative changes in the tissues were wrought, yet the years of careful work he devoted to searching, failed him in finding the slightest trace of ozone in the blood.

In his later years he became equally emphatic in his assertion that the resolution of ozone—its oxidation was so rapid that in the blood and the moistened tissues surrounding the capillaries where the real respiration is accomplished it would be next nigh impossible to chemically detect the presence of ozone by the most delicate test. He even went so far to doubt its existence in the blood, that is to say, he believed that it was ushered into existence and was used up in performing its functions so quickly that it was not possible to chemically isolate it, that in the blood of the capillaries—presumably the radicals, although he does not so put it—where the pressure conditions are such as to allow of the free interchange of the gases of the blood with the tissue elements, ozone no longer existed.

Like many other great minds, Schönbein was right in many of his claims, but in many other of his theories he allowed himself to fall into error, for in justice to those who come after him to study this question of the physiological significance of ozone, and with no discredit to his greatness, Schönbein left much to be cleared up and explained. The everchanging and improving chemical facilities and knowledge make this task far more easy. With the advantages afforded by the chemistry of his day, Schönbein accomplished an Herculean task. That famous physiologist, His, who had grown up in the shadows of Schönbein's laboratory and influence also failed to discover ozone in the blood.

At the very time His was engaged in his futile efforts, Alexander Schmitt was at work upon the same question—ozone in the blood.

We need not rehearse the details of Schmitt's methods, suffice it to say his experiments were elaborate and carefully made, and showed beyond doubt that ozone existed in the blood; but the quantity, apparently, was very small.

Not long afterwards Kühne, improving on Schmitt's tests, proved that ozone existed in the blood in readily appreciable quantity, and the question was for ever settled in the affirmative.*

Kühne concluded, and his deductions were not far from approximating the truth, that the red corpuscles greedily absorb ozone under the natural formation of carbonic acid, and decompose water as free oxygen is liberated.

Our experiments on the blood with the galvanic current are in a line with those of Kühne and Schmitt, only a short step in advance of those observers, a mere completion of their unfinished tasks. Whatever value the results we have obtained may have there can be no doubt that the galvanic current applied to the living body, whatever else its action may be, increases the amount of ozone both in the corpuscle and the plasma.

Before entering into a rehearsal of the details of our experiments, let us briefly touch upon the physiology of the blood and the function of its gases; for here it was that we suspected the seat of first physiological action of the galvanic current, and here, too, we were led to trace to its source, animal electricity, and observe its function as we suppose it, in the human economy.

THE BLOOD—ITS GASES AND SOLIDS.

The gases in the blood, the carbonic acid, the nitrogen and the oxygen, which interests us in particular, need not be gone into at length.

The oxygen in the blood exists in two forms. First, that which is held in solution by the plasma, and second, that which enters into combination with the constituent elements of the corpuscle.

* Kühne & Scholz, *Virchow's Archiven*, 1865.

The first variety commands our attention for the reason that to all appearances, the galvanic current first acts upon this freely dissolved oxygen, and which naturally, therefore, first undergoes the transforming change from O_2 into O_3.

With a single exception, that of defibrinated blood, the blood obeys Dalton's well-known law of the absorption of gases by liquids. In vacuum 100 volumes of blood give up a trifle over 72 volumes of gas, of which in arterial blood 20 volumes, upon analysis, consist of oxygen, while in venous blood the volume is reduced to between 8 or 10.

The plasma simply holds the oxygen in solution, while the haemoglobin, which by actual weight makes up 90 per cent. of the dried corpuscle, enters into partial combination with the oxygen, although we have observed, and the observations are in keeping with those of other observers, that the oxygen in the haemoglobin is in such a loosely combined state, that it readily solves its bonds of union, and under the slightest provocation goes over to the other elements for which it has affinity as soon as the pressure conditions of the plasma are changed so as to permit of a loosening of its bonds.

Plasma, or to be more accurate, fresh serum, will, upon exposure to the air, absorb no more gas than ordinary water under similar conditions, some three volumes; defibrinated or whipped blood, however, contrary to what might be expected, takes up considerably more. This will suffice for the behaviour of the gases of the blood. Now a word about its solid constituents.

In general, in the plasma they are serum, albumen, globulin and crystallisable fatty and nitrogenous matter which, as we shall endeavour to show, are rendered more diffusible by this very transformation of oxygen into ozone, caused by the polarising action of the existing animal electricity of the body, and rendered even more diffusible by the action of the galvanic current.

In the larger vessels, for example, the carotid artery which we have chosen as the seat of our experimentation, not only because it is accessible and convenient, but rather because it is a direct branch of the aorta where both the plasma and corpuscles are equipped with all the oxygen they can carry, the blood is charged to its full capacity with those elements which it is commissioned to give up to and upon which the tissues depend, particularly oxygen.

All physiologists agree that in these large vessels carrying arterial blood the haemoglobin in the corpuscle is in the form of oxy-haemoglobin, which signifies simply that the haemoglobin has entered into partial combination with as much oxygen as it can hold, and that it is ready to transfer this oxygen to the tissues as soon as the oxygen of the plasma has become exhausted, and the pressure conditions become so reduced as to permit the giving up of the gas.

This occurs in the capillaries. Until these are reached the pressure of the oxygen in the plasma restrains the haemoglobin from giving its oxygen. Here, in the liquid moistening the febrillæ of muscle that surround the terminal capillaries where the transfer of oxygen in reality begins, the tension of the oxygen is almost nil, since the tissue elements are steadily taking up the gas from the lymph surrounding them, and the plasma continues to give up oxygen through the walls of the capillaries until the tension falls too low for it to longer do so; then it is that a portion of the oxygen of the hæmoglobin is freed and is dissolved in the plasma to take the place of that oxygen which it has given up and which in turn has passed out into the lymph on the other side of the capillary wall. This interchange continues until the pressure of the oxygen in the lymph equals that of the oxygen in the plasma, by which time the venous system of capillaries, the return circulation, has been reached.

One of the strong indications of the action of the galvanic current on the blood is the probability that it facilitates this transfer of oxygen to the tissues in active form, both chemically and physically. By rearranging the atoms of some of the molecules of oxygen in the plasma the volume of the oxygen held in solution is reduced, and the oxygen of the hæmoglobin is at once transferred to the plasma instead of being doled out, as it were, to suit the constantly varying pressure changes that go on as the blood completes its circulatory round. This being the case, the transforming process is undoubtedly ushered into existence through the polarising property of the animal electricity, of which we shall speak further on.

How far chemical change is wrought upon the diffusible solids of the blood by the generation and presence of such an increased amount of ozone, we are unable to make precise answer, and we leave it to the thoughtful investigation of those observers who may take interest in our work and who are blessed with a more acute knowledge of physiological chemistry and a more completely equipped laboratory than it is our good fortune to possess. To our mind there seems little question of the occurrence of just such a change as we have described. Our analyses thus far, have remained within the sphere of quality; it remains for others to continue in the more exact line of quantity. Reasoning by analogy, the galvanic current acts precisely upon the oxygen in solution in the plasma as it did in the jar filled with O_2 through which Schönbein passed the current and observed its transformation into ozone.

There is but one possible action of the ozone on the blood. It must hurry on the transfer of the oxygen to the tissues, call into existence the oxidation of those constructive elements which the tissues require for their revivification. Doubtless, these changes are more extensive than we have been able to determine.

OTHER FACTORS TO BE CONSIDERED.

The experiments of Guy-Lassan should teach us a valuable physiological lesson. From his laboratory we feel that we can carry them over to that storehouse of chemical energy—the human body; and observe changes corresponding to those he observed in his jars filled with gases possessed of great affinity for one another which, however, remained quiescent and inactive until he prodded them with the stimulus of a galvanic current, which, as it passed through the gases, spurred into action, or awakened, as it were, their slumbering affinities,

polarised their molecules and ushered into life the new something, the result of the three great potent factors—polarisation, chemical action and affinity. We have tried to impress upon you the importance of these three conditions, for upon them depend all the chemico-physiological changes—in short, all changes that go on within the human body.

We have observed them time and again in the course of our experimenting, and we have subjected them singly and together to the most rigorous test of verification.

Our observations point to the one conclusion, and that is, that chemical action, the feeder of life, cannot go on unless there is present an electrical force, an energy that can polarise the molecules of the combining elements and prepare them for combining action. Affinity, catalytic force, the phenomena of contact, in themselves are impotent without that ever preceding factor—molecular polarisation.

It is the metabolism, the anabolism, the katabolism, the all, and more were it possible, of that cardinal nourisher of tissues, that feeder of life, the blood.

Animal electricity, and the important part it plays, we will reserve for a later chapter, and pass over to general details of our experiments upon the blood of the living animal in its normal state and under the stimulus of the galvanic current.

(To be continued.)

THE ELECTRICAL RESISTANCE OF METALS AND ALLOYS AT TEMPERATURES APPROACHING THE ABSOLUTE ZERO.*

BY JAMES DEWAR, LL.D., F.R.S., AND J. A. FLEMING, M.A., D.Sc., F.R.S.

THE general object of this research was the determination of the specific electrical resistance of metals and alloys between the limits of temperature of about 200° C., and the lowest obtainable temperatures approaching the absolute zero. The authors particularly desired to investigate the variation of resistance with temperature below − 100° C., and to determine the form of the temperature resistance curves as the temperature is lowered down to the lowest points obtainable by the evaporation of liquid oxygen boiling under reduced or normal pressure.

One part of the work consisted in the determination of the mean cross-section of a series of very fine wires prepared from the metals and alloys under test, taken by means of an optical method. From this mean cross-section and the length, the authors were able to state when the resistance is known, the volume-specific resistance of the material. Pending the determinations of the temperature-change in dimensions of the metals and alloys employed, the authors omit the correction (no doubt small) due to the change of dimensions, and state their results in terms of the electrical resistance in electro-magnetic measure of one cubic centimetre of the material measured at 15° C., the said electrical resistance being determined at the various temperatures to which the material is raised or lowered. The temperatures employed were determined in terms of the variation of the specific resistance of platinum.

The general nature of the measurements made consisted, therefore, first, in the measurement of the length and mean diameter of a fine wire of a metal or alloy of carefully prepared quality; secondly, in the measurement of the resistance of this wire when immersed in a bath giving it the necessary temperature; and thirdly, the determination of this temperature of the bath by the measurement of the resistance of the standard platinum wire before and after the measurement of the given wire. From the results of these observations, the volume-specific resistance of the material at certain platinum temperatures were determined, and a series of curves to represent the variation of this resistance with temperature plotted out.

The different wires had a diameter varying from ·08 millim. (3 mils) up to about 0·25 millim. (10 mils), and lengths of from 1 to 3 metres.

Generally about 20, and sometimes 60 diametral measurements were taken in the metre length of the wire to be measured.

The wire to be tested, generally 1, 2, or 3 metres in length, was carefully wound on a vulcanised fibre cylinder in between silk thread, the several turns of which kept the turns of wire from becoming short circuited. The dimensions of the cylinder of vulcanised fibre varied according to the length of wire used, but was from 2 to 3 centimetres in diameter and 4 to 5 centimetres in length.

The so prepared resistance coils were immersed in melted paraffin wax and kept at a temperature of 200° C. for some time. These being slowly cooled they were annealed, and at the same time the insulating portions of the coils well saturated with paraffin.

The resistance measurements were carried out by means of a Wheatstone's bridge.

The temperatures above zero Centigrade were obtained by immersing the coils in a beaker of melted paraffin oil standing in a large zinc bath full of water. The temperatures below zero Centigrade were obtained by the use of a bath of carbonic acid snow, and ether, or paraffin oil, which gave temperatures according to desire from 0° C. down to about −78° C., and a series of measurements was thus made at about −40° and −78°. By the employment of liquid ethylene a temperature of −100° C. could be reached. Liquid oxygen was then employed as a refrigerating agent to lower the temperature of the resistance coils to about − 182° C. The liquid gas was contained in vacuum-jacketed flasks or test-tubes in which the resistance coil was placed.

Temperatures lower than the above limits were obtained by closing the mouth of the vacuum-jacketed test tube with a tightly-fitting India-rubber cork and producing a partial vacuum above the liquid oxygen. In these experiments the resistance coils were therefore immersed in liquid oxygen boiling under a very reduced pressure, as low as 14 millimetres of mercury.

The following are the principal results obtained:—

I.—PLATINUM.

The observations taken with thick platinum wire were as follows:—

R_t. Corrected resistance of wire in ohms.	$t°$. Corrected Centigrade temperature.	ρ_t. Volume specific resistance.	pt. Platinum temperature.	Remarks on nature of bath.
5·2171	195·2	18,388	192·2	Taken in melted paraffin wax.
4·6345	141·0	16,334	139·8	
4·1876	98·5	14,759	98·55	Taken in paraffin oil.
4·1813	98·05	14,737	98·10	
3·9982	80·90	14,092	81·20	
3·7695	60·0	13,286	60·55	
3·5440	39·60	12,491	40·15	
3·3108	18·45	11,669	18·85	
3·3043	17·90	11,646	18·25	
3·2991	17·20	11,628	17·55	
3·2739	14·90	11,539	15·20	
3·2487	12·80	11,450	13·10	
3·2450	12·60	11,437	12·85	
3·1136	0·60	10,974	0·60	Taken in melting ice.
2·8034	...	9,881	− 27·8	Taken in paraffin and solid carbonic acid.
2·6222	...	9,242	− 44·0	
2·4225	...	8,538	− 62·7	
2·2085	...	7,784	− 81·9	Taken in solid carbonic acid and ether
2·0138	...	7,098	− 99·8	Taken in liquid ethylene.
1·9446	...	6,854	−106·1	
0·9473	...	3,339	−197	Taken in liquid oxygen boiling at 760 millim.
0·6951	...	2,450	−219·7	Taken in liquid oxygen boiling under reduced pressure.
0·6921	...	2,439	−219·9	

Volume-specific resistance at 100° C. = 14,814 C.G.S. units.
Ditto ditto at 0° C. = 10,950 „ „
Mean temperature coefficient between 0° and 100° C.... ... ... = ·003529.

II.—GOLD.

R_t.	$t°$.	ρ_t.	pt.	Remarks.
7·8048	194·5	3,792·1	191·5	In melted paraffin.
6·7068	132·2	3,258·6	131·2	
6·0538	90·4	2,941·3	90·55	In paraffin oil.
4·7882	50·0	2,606·5	50·6	
4·8319	18·7	2,347·7	19·1	
4·7882	16·25	2,326·4	16·6	
4·7726	15·4	2,318·8	15·7	
4·7636	14·3	2,314·5	14·6	
4·7208	11·95	2,293·7	12·2	
4·5296	1·05	2,200·8	1·05	In melting ice.
3·8056	...	1,849·0	− 44	
3·1870	...	1,548·5	− 81·9	In CO_2 and ether.
2·8131	...	1,366·8	−106·1	In liquid ethylene.
1·4022	...	681·3	−197·1	In liquid oxygen.

Volume-specific resistance at 0° C. ... = 2,197 C.G.S. units.
Mean temperature-coefficient between 0° C. and 100° C.... ... ... = ·00377.

IV.—SILVER.

R_t.	$t°$.	ρ_t.	pt.
0·7631	192·1	2,608·4	189·2
0·6652	137·2	2,273·7	136·1
0·6033	98·15	2,062·2	98·2
0·5372	60·0	1,836·2	60·55
0·4646	18·30	1,588·1	18·70
0·4601	18·20	1,572·7	18·60
0·4639	17·25	1,585·7	17·60
0·4355	0·65	1,488·6	0·65
0·3630	...	1,240·8	− 42·3
0·2988	...	1,021·3	− 81·9
0·1140	...	389·7	−197·1

Volume-specific resistance at 0° C. ... = 1,468 C.G.S. units.
Mean temperature-coefficient between 0° C. and 100° C. ... ... = ·00400.

* Abstract of article in the *Philosophical Magazine*, September, 1893, and the subject of our leader of last week.

V.—COPPER.

R_t.	$t°$.	ρ_t.	pt.	Remarks.
1·6810	205·0	2,926·9	201·7	Taken in melted paraffin.
1·4346	141·1	2,497·7	139·9	
1·2726	97·95	2,215·8	98·0	Taken in paraffin oil.
1·1262	59·95	1,960·9	60·50	
0·9659	18·30	1,681·8	18·70	
0·9658	18·25	1,681·6	18·65	
0·9594	16·45	1,670·5	16·80	
0·8982	0·55	1,563·9	0·55	Taken in melting ice.
0·7452	...	1,297·5	− 39·4	
0·5883	...	1,024·3	− 81·9	Taken in CO_2 and ether.
0·1658	...	288·7	−197·1	Taken in liquid oxygen boiling at 761 millim.

A longer coil was then employed to obtain resistance ratios at lower temperatures reached by the use of liquid oxygen boiling under reduced pressures. The measurements being as follows:—

R_t.	$t°$.	ρ_t.	pt.	Remarks.
1·1687	...	288·7	−197·1	Taken in liquid oxygen boiling under pressures down to 14 millim. of mercury.
0·6391	...	161·3	−219·2	
0·6341	...	160·0	−219·3	
0·5692	...	143·6	−223·2	

Volume-specific resistance at 0° C. ... ... = 1,561.
Mean temperature-coefficient between 0° and 100° C. = ·00428.

VI.—ALUMINIUM.

COMMERCIAL ALUMINIUM, 97·5 PER CENT., FINE.

R_t.	$t°$.	ρ_t.	pt.	Remarks.
1·0352	193·3	4,898·1	190·4	
0·9134	144·4	4,321·8	143·0	
0·7887	91·45	3,731·8	91·6	
0·6869	50·1	3,250·1	50·7	
0·6064	18·85	2,869·2	19·25	
0·6021	15·65	2,848·9	15·95	
0·5671	1·0	2,683·2	1·0	
0·4577	...	2,165·6	− 44·3	
0·3672	...	1,737·6	− 81·9	
0·3127	...	1,479·5	−106·1	In liquid ethylene.
0·1070	...	506·3	−197·1	In liquid oxygen.
0·3744	...	506·3	−197·1	This ratio was obtained from a longer coil of the same wire immersed in oxygen boiling under reduced pressure.
0·2402	...	324·8	−219·2	

Volume-specific resistance at 0° C. ... = 2,665 C.G.S. units.
Mean temperature-coefficient between 0° C. and 100° C. ... ... = ·00435.

VII.—IRON.—IRON A.

R_t.	$t°$	ρ_t.	pt.
4·1935	197·3	23,251	194·2
3·4091	138·8	18,902	137·6
2·8368	90·5	15,729	90·7
2·4167	52·10	13,399	52·70
2·0737	18·50	11,498	18·90
1·9104	1·40	10,592	1·45
1·5086	...	8,364	− 43·6
1·1909	...	6,647	− 81·9
0·4223	...	2,341	−197·1

By comparison of resistances of a longer coil of the same wire taken in liquid oxygen boiling under normal and reduced pressures a lower temperature reading was obtained.

R_t.		ρ_t.		pt.
3·834	.....	2,341	.....	− 197·1
2·983	.....	1,820	.....	− 219·4

Volume-specific resistance at 0° C. ... = 10,512
Mean Temperature-coefficient between 0° and 100° C. ... ... = ·00544

IRON H. W.

R_t.	$t°$.	ρ_t.	pt.	Remarks.
5·1395	196·1	21,499	193	
4·2536	145·4	17,793	144	
3·4976	98·10	14,631	98·15	
2·9546	60·25	12,359	60·80	
2·3940	18·25	10,014	18·65	
2·1791	0·70	9,115	0·70	
1·7137	...	7,168	− 39·2	
1·2713	...	5,318	− 81·9	Taken in CO_2 and ether.
0·2918	...	1,220	−197·1	Taken in liquid oxygen boiling at 760 mm.

Two other coils (*a*) and (*b*) of the same wire were also prepared, so as to obtain a much greater resistance to measure; and these coils had their resistances taken in liquid oxygen boiling under normal and under reduced pressures. Hence lower temperature readings were obtained as follows:—

Iron H. W. (*a*).			Iron H. W. (*b*).		
R_t.	ρ_t.	pt.	R_t.	ρ_t	pt.
7·091	1,220	−197·1	9·875	1,220	−197·1
4·154	725	−219	5·257	649	−222·4
3·839	660	−222·2	5·222	644	−222·7

Volume-specific resistance at 0° C. ... = 9,065 C.G.S. units.
Mean temperature-coefficient between 0° C. and 100° C. ... ... = ·00625.

It will be seen, therefore, that Iron H. W. has a much greater conductivity (about 15 per cent.) than Iron A, and also a much larger temperature-coefficient.

VIII.—NICKEL.

R_t.	$t°$.	ρ_t.	pt.
1·8475	195·3	29,730	192·3
1·4448	133·7	23,250	132·7
1·2067	90·35	19,419	90·55
1·0058	51·7	16,185	52·3
0·8484	18·7	14,653	19·10
0·7707	1·30	12,402	1·35
0·5876	...	9,456	− 43·6
0·4500	...	7,242	− 81·9
0·1185	...	1,908	−197·1

Volume-specific resistance at 0° C. ... ... = 12,323.
Mean temperature-coefficient between 0° C. and 100° C. ... ... = ·00622.

Similar experiments were also made with palladium, tin, zinc, cadmium, lead and thallium.

The conclusion reached in a former paper is confirmed by these more careful experiments, viz., that the electrical specific resistance of all *pure* metals will probably vanish at the absolute zero of temperature.

Tables I., II., III., and IV., show general tabulated results of the experiments.

TABLE III.—Volume-Specific Resistances (ρ_0) in C.G.S. units of Alloys at 0° C., and Temperature Coefficients (α) at 15° C.

	ρ_0.	α_{15}.
Platinum-silver	31,582	·00243
Platinum-iridium	30,896	·000822
Platinum-rhodium	21,142	·00143
Gold-silver	6,280	·00124
Manganese-steel	67,148	·00127
Nickel-steel	29,452	·00201
German-silver	29,982	·000273
Platinoid	41,731	·00031
Manganin	46,678	·0000
Silverine	2,064	·00285
Aluminium-silver	4,641	·00238
Aluminium-copper	2,904	·00381
Copper-aluminium	8,847	·000897
Copper-nickel-aluminium	14,912	·000645
Titanium-aluminium	3,887	·00290

TABLE I.—Volume-Specific Resistances (ρ_t) of Alloys at various Temperatures (pt).

Alloy.	In boiling water.	Ordinary temp.	In melting ice.	In CO_2 and ether.	In liquid ethylene.	In liquid oxygen boiling at 760 mm.	In liquid oxygen boiling in vacuum.
Platinum-silver. P = 33 p.c. Ag = 66 p.c.	ρ = 32,296 pt = 93·25	31,726 16·1	31,573 1·85	30,964 − 81·9	30,790 − 106·1	30,173 − 197·1	
Platinum-iridium. Pt = 80 p.c. Ir = 20 p.c.	ρ = 33,271 pt = 93·3	31,296 16·1	30,933 1·8	28,836 − 81·9	28,347 − 106·1	26,031 − 197·1	
Platinum-rhodium. Pt = 90 p.c. Rd = 10 p.c.	ρ = 23,943 pt = 92·25	21,635 16·15	21,188 1·75	18,648 − 81·9	18,065 − 106·1	15,134 − 197·1	
Gold-silver. Au = 90 p.c. Ag = 10 p.c.	ρ = 6,997 pt = 91·65	6,417 16·4	6,293 0·9	5,666 − 81·9	5,510 − 106·1	4,817 − 197·1	
Aluminium-silver. Al = 94 p.c. Ag = 6 p.c.	ρ = 5,686 pt = 92·5	4,824 16·25	4,654 0·9	3,723 − 81·9	3,477 − 106·1	2,484 − 197·1	
Aluminium-copper. Al = 94 p.c. Cu = 6 p.c.	ρ = 3,972 pt = 92·4	3,087 16·35	2,911 0·95	1,960 − 81·9	1,715 − 106·1	719 − 197·1	
Copper-aluminium. Cu = 97 p.c. Al = 3 p.c.	ρ = 9,575 pt = 92·25	8,990 16·35	8,860 0·85	8,210 − 81·9	8,044 − 106·1	7,328 − 197·1	
Hadfield's manganese-steel. Mn = 12 p.c.	ρ = 75,294 pt = 89·9	68,520 16·15	67,222 1·0	61,236 − 81·9	60,042 − 106·1	55,414 − 197·1	
Hadfield's nickel-steel. Ni = 4·35 p.c.	ρ = 35,185 pt = 91·15	30,402 16·15	29,515 0·95	24,897 − 81·9	23,750 − 106·1	19,468 − 197·1	
Manganin. Cu = 84 p.c. Mn = 12 p.c. Ni = 4 p.c.	ρ = 47,528 pt = 91·60	47,640 16·25	47,636 0·9	47,387 − 81·9	47,225 − 106·1	45,825 − 197·1	45,270 − 217

TABLE II.—Volume-Specific Resistances (ρ_t) of Alloys at various Temperatures (pt).

Alloy.	In boiling water.	Ordinary temp.	In melting ice.	In CO_2 and ether.	In liquid ethylene.	In liquid oxygen boiling at 760 mm.
German-silver.	ρ = 30,731 pt = 92·25	30,112 16·2	29,987 0·9	29,297 − 81·9	29,132 − 106·1	28,317 − 197·1
Platinoid.	ρ = 42,884 pt = 92·85	41,938 16·25	41,745 0·9	40,683 − 81·9	40,413 − 106·1	39,189 − 197·1
Titanium-aluminium.	ρ = 4,936 pt = 90·85	4,076 16·4	3,898 0·85	2,943 − 81·9	2,705 − 106·1	1,658 − 197·1
Silverine. Cu = 77 p.c. Ni = 17 p.c. Fe = 2 p.c. Zn = 2 p.c. Co = 2 p.c.	ρ = 2,614 pt = 90·5	2,166 16·25	2,071 0·95	1,582 − 81·9	1,452 − 106·1	909 − 197·1
Copper-nickel-aluminium. Cu = 87 p.c. Ni = 6·5 p.c. Al 6·5 p.c.	ρ = 15,785 pt = 91·45	15,066 16·35	14,921 0·9	14,132 − 81·9	13,939 − 106·1	13,048 − 197·1

TABLE IV.—Volume-Specific Resistances in C.G.S. Units of Pure Metals at 0° C., and Mean Temperature Coefficients between 0° and 100° C. The metals in all cases soft and annealed.

Metal.	ρ_0.	α_{0-100}.
	C.G.S. units.	
Platinum	10,917	·003669
Gold	2,197	·00377
Palladium	10,219	·00354
Silver	1,468	·00400
Copper	1,561	·00428
Aluminium	2,665	·00435
Iron	9,065	·00625
Nickel	12,323	·00622
Tin	13,048	·00440
Magnesium	4,355	·00381
Zinc	5,751	·00406
Cadmium	10,023	·00419
Lead	20,380	·00411
Thallium	17,633	·00398

THE KENSINGTON VESTRY AND ELECTRIC LIGHTING.

THE following is the second and concluding portion of the report of the Special Electric Lighting Committee of the Kensington Vestry by Major-Gen. Webber, R.E., and Mr. Philip Monson, lighting engineer to the vestry.

ADVANTAGES OF THE SCHEME.

As to the advantages which it is suggested, or can be shown would accrue to the consumers and ratepayers generally by the vestry undertaking the supply of electricity for public and private purposes throughout the whole or any part of the parish, the experts say we believe we are right in regarding the question of the vestry becoming undertakers for the supply of electricity in competition with the existing supply companies within the areas allotted to them, as one which is not at present ripe for consideration, as it opens up questions of demand, supply, and profitable expenditure of capital of a very complicated nature. It seems desirable at this stage of our report to remind the vestry that in the last five years the distribution of electrical energy, both for light and power, in towns all over the world, has reached a position of practical application as an industry, not only as a public necessity, but also as a remunerative investment, not far behind that which has been attained by its elder sisters, namely, the supplying of gas and water. In other words, that it is well advanced into its period of adolescence, and that all the conditions which are required to make it pay are thoroughly understood. The anticipations during the early history of electric lighting in this country as to its general adoption have been disappointed, because of their exaggeration; but estimates made 10 years ago of the probable demand in residential districts in London, based on one private house in three using the light within five years of starting to supply current, have been more than fulfilled. There are reasons why such an estimate, based on one house in four as regards the district with which it is proposed to deal should not be again excessive, in spite of the fact that in the latter the average rateable value of the property is much below that of other parts of Kensington.

The reasons are as follows:—It is found that the wiring of existing houses for the electric light is not often done, except when the occupation changes. The owner has less inducement to wire his houses when once they are let, and the tenant for a term will rarely incur the outlay on a house not his own. Shorter tenure of occupation entailing more frequent changes of occupiers, which is the case in the

less wealthy districts, should therefore give more frequently need and opportunity to carry out wiring. Wiring and fittings are costing 50 per cent. less than they did five years ago. This applies especially to fittings. For instance, a good 20-light distribution board can be now procured for about 18s., instead of former prices varying between £2 and £5. Excellent energy meters, satisfactory to the Board of Trade, will shortly be sold for less than 30s. Glow lamps will shortly be sold for 1s. 3d. new, and be repairable for 6d. each, and there can be no doubt that a greater efficiency of the filament will ere long be provided, so that the same light will be yielded with a less consumption of current than now. If, in addition, the vestry can, without incurring a loss, sell current for 5½d. a Board of Trade unit, which is equivalent to 16 candle gas at 3s. 1d. per 1,000 cubic feet in the ordinary burners, the conditions for bringing this illuminant within the reach of all who now use gas are obtained, and the consumers will reap besides all the advantages to health and comfort, economy and safety, recognised as accompanying the use of electricity.

AGAINST THE INDUCEMENTS.

As against the above inducements to an extension of the use of electric light into such districts based on the usual condition which naturally influences an electric light supply company, namely, that it is an illuminant only accessible to the wealthy, we have compiled tables which divide the custom between private houses and shops, and which also subdivide the same in groups according to rating, so that the proportion of each kind in each electric light district may be seen at a glance. The figures in the tables show clearly the preponderance of the number of houses and shops at the lower ratings in districts 1 and 2 as compared with the others. The areas under consideration are shown by a map, which is attached to this report, and include about $\frac{3}{4}$ths of the parish and lie to the north of Uxbridge Road, Ladbroke Grove, and Archer Street. Their length together is approximately 1½ miles from north to south, and 8½ furlongs from east to west. The following streets and portions of streets that we have selected and propose should be dealt with first are coloured on the map, and are selected as those in which a demand under the conditions we have mentioned may be fairly expected:—Bassett Road, Blenheim Crescent, Cambridge Gardens, Colville Square, Colville Terrace, Clarendon Road, Elgin Crescent, Ladbroke Gardens, Ladbroke Grove Road, Ladbroke Grove, Lancaster Road (part of), Lansdowne Road, Lansdowne Crescent, Norland Square, Oxford Gardens, Portobello Road (part of), Powis Square, Royal Crescent, St. Charles Square, St. Mark's Road, and Uxbridge Road. The total length of street in which mains should be laid along both sides is about 4·6 miles, and along one side only is about 1·4 miles. Total, about six miles of street. In the following list of totals the shops and private houses in those streets are again distinguished and grouped, and under an estimate of the number of lights each may be expected to require, a possible total of 40,390 8-C.P. glow lamps that may be eventually installed, is obtained:—

HOUSES.

204	under	£50	rating,	each	10	lights	2,040
773	„	£100	„	„	20	„	15,460
289	„	£150	„	„	35	„	10,115
38	„	£250	„	„	60	„	2,280
6	over	£250	„	„	100	„	600
							30,495

SHOPS.

25	under	£50	rating,	each	15	lights	375
117	„	£100	„	„	30	„	3,510
59	„	£150	„	„	50	„	2,950
14	„	£250	„	„	90	„	1,260
12	over	£250	„	„	150	„	1,800
							9,895
						Total	40,390

The analysis of the above from metropolitan and other experience and results, and in view of the increased opportunities and inducements we have mentioned, permit an estimate of the probable number of lights that will be joined up during the first three years at

One-fourth	of	30,496	= 7,623
One-third	of	9,895	= 3,298
		Total	10,921

Of these we calculate that in houses five-sevenths = 5,445, and in shops six-sevenths = 2,826, will be in use at one time, giving a total for which plant should be provided of = 8,271. These figures indicate that the minimum capacity of the installation to be put in hand for the supply of private lighting should be for 8,500 8-C.P. lamps in use at one time, which at 33 watts per lamp at the terminals and 35 at the station, requires a plant that without spares should have a capacity of output of 300 kilowatts.

For the public lighting of main thoroughfares, two routes are plainly indicated as capable, in the first instance, of being supplied from a station at Kensal Wharf, namely: First, Ladbroke Grove and Ladbroke Grove Road, lying north and south; and second, the Uxbridge Road, from Norland Road on the west side, to Kensington Gardens on the east, the united length of thoroughfare being about 2½ miles. As regards this service of public lighting, if the vestry desires to undertake it, and on economical grounds there are good reasons why they should do so, there are no difficulties, and it can be done in conjunction with the private supply in districts 1 and 2, and independent of the private lighting in part of No. 3, now served by the Notting Hill Electric Light Company. This 2½ miles, assuming that arc lamps, giving the same light as those used in the City of London are employed, and that these are placed at an average of about 70 yards apart, or 25 to the mile, will require about 63 kilowatts, raising the total capacity of the station to be first equipped to 363 kilowatts, without spares. Including spares, therefore, we are of opinion that the equipment of the station available for distribution, should not be less than 500 electrical horse-power.

ANNUAL CHARGES.

The annual charges on the debtor and creditor sides for the electric lighting alone, without combining it with the destruction of refuse, are as follows:—

Debtor.—Interest and redemption at 4½ per cent. on £31,000, £1,395; works cost, at 2·95 of a penny on 253,024 units, made for public and private lighting, £3,110; office and management and collection, £500; depreciation, £832; attendance and trimming 63 arc lamps, £300; total, £6,137.

Creditor.—Value of 133,224 units, 12 units to each private lamp, and 24 units to each shop lamp, per annum, nearly 8½d. a unit, £4,577; value of 63 arc lamps (nominal 2,000 C.P.), at £20, £1,260; public gas lamps discontinued, £300; total, £6,137, showing that if sold at cost price to the vestry, 8½d. a unit would have to be charged for the electricity.

The following is a similar statement for the destruction of refuse alone:—

Debtor.—3½ per cent. on £8,680, cost of destructor, £390; depreciation and repairs, 3½ per cent., £304; superintendence working, £20 a week, £1,040; clinker, ashes, &c., remaining on 25,000 tons of refuse, 8,250 tons, including lifting, 3s., £1,237; total, £2,971, less saving, £570; total, £3,541.

Creditor.—Barging at present rates, 25,000 tons at 2s. 10d. from Kensal Wharf, £3,541.

Lastly follows a statement showing that the price at which the vestry could sell electricity if the two are combined might even be as low as 4½d. per Board of Trade unit:—

Debtor.—Interest and redemption on £31,000, £8,680; £39,680 at 4½ per cent., £1,785; depreciation, £1,136; superintendence and working of destructors, boilers and plant, £1,040; electrical works cost, less coal and stoking at 1·48 of a penny per unit made, £1,556; office management and collection, £500; removal and lifting remains of refuse, £1,237; trimming and attendance of arc lamps, £300; total, £7,554.

Creditor.—Saving on barging, £3,541; public lighting, £1,260; private light, at about 4¾d. per unit, £2,453; public gas lamps discontinued, £300; total, £7,554.

The above shows that if the vestry sells electricity at 5½d. a unit to private consumers, as soon as the station is nearly fully occupied, there could be made a profit in favour of the ratepayers of about £550 a year. We have been careful in the above estimates not to minimise the charges on the debtor side, and it is clear that when the demand for current justifies an increase of the generating plant, the results will be very much better. As regards the questions which the committee require us to answer, we believe that the above results fully justify us in giving an affirmative to each, and also in recommending the vestry to proceed without delay for powers under a provisional order to deal with the whole parish; after which it will be time enough to give instructions for the detailed plans, estimates, and specifications to be put in hand. For reasons already mentioned, we should suggest that except for public lighting, and where the existing companies fail to give a supply, the vestry may let the Board of Trade understand that for the present they propose to confine their operations to Districts 1 and 2.

OVER HALF A MILLION.

In conclusion, we wish again to point out that the figures we have given show that any report which dealt with the question of the supply of the whole parish, in a manner adequate to the future maximum demand, means that an expenditure of over half a million would have to be considered, and that then the annual economy on the working due to the use of house refuse as a fuel for generating steam, would affect but a small fraction of the total running costs. Such a report might have besides to deal with questions connected with the acquisition by purchase of the undertakings of the existing electric light companies, whether that acquisition took place at an early date, or was deferred to the end of the statutory period of 42 years. Throughout the provinces the local authorities are everywhere becoming undertakers under the Electric Lighting acts, and there are already examples of it in the metropolis. The commercial considerations must be weighed equally, whether the supply is by a private or public body, and it requires the lapse of some little time longer to show whether the latter can deal successfully with the question, apart from the exceptional advantages afforded, as in the case presented by this report, through the utilisation of the house refuse.

The report will be considered at a special meeting of the vestry, to be held on the 22nd inst.

NEW PATENTS—1893.

20,432. "Improvements in electric stop motion drawing frames for fibrous materials." E. TWEEDALE, S. TWEEDALE, and J. SMALLEY. Dated October 30th. (*Complete.*)

20,458. "An electric switch." E. C. DE SEGUNDO. Dated October 30th. (*Complete.*)

20,459. "Improvements in suspension devices for electric crown lights and the like." E. REDANTZ. Dated October 30th.

20,471. "Improvements in incandescent electric lamps." J. G. TATTERS. Dated October 30th.

20,493. "An improved electric flash light clock." H. Y. DICKENSON. Dated October 30th.

20,551. "A new or improved combined switch and cut-out for electroliers." H. BIRKBECK. (Communicated by the Universal Pull Socket and Switch Company, United States.) Dated October 31st.

20,557. "Improvements in electrical switches." E. REDANTZ. Dated October 31st.

20,584. "Improvements in the manufacture of elements for electric or secondary batteries." A. J. MARQUAND and E. HANCOCK. Dated October 31st.

20,625. "Improvements in and connected with carbon electrode connections." H. T. BARNETT. Dated November 1st.

20,686. "Improvements in electrical condensers." W. E. GRAY and W. A. PRICE. Dated November 1st.

20,698. "Improvements in and in connection with electric cables." G. G. M. HARDINGHAM. (Communicated by the firm of Felten and Guilleaume, Germany.) Dated November 1st. (*Complete.*)

20,715. "An electrical healing apparatus." W. E. F. RUCKERT. Dated November 1st. (*Complete.*)

20,723. "Improvements in electric measuring instruments." W. T. GOOLDEN and S. EVERSHED. Dated November 2nd.

20,732. "An electrical or mechanical apparatus in connection with a ship's sounding lead, or for cognate purposes." W. ALDRED. Dated November 2nd.

20,735. "Improvements in lightning conductors." J. BALL. Dated November 2nd. (*Complete.*)

20,741. "Improvements in swing or movable joints especially adapted for electric light fittings." J. A. LEA, J. F. LEA, and A. H. LEA. Dated November 2nd.

20,788. "Improvements in electric stop motions for warping machines." C. DENN, J. COCKER, and C. DENN. Dated November 2nd.

20,793. "Improvements in recording instruments for electric telegraphs." A. MUIRHEAD. Dated November 2nd.

20,799. "Improvements in electric incandescent lamps." M. H. HARTOGH. Dated November 2nd. (*Complete.*)

20,816. "Improvements in connectors for electric conductors." H. R. KEITHLEY. Dated November 2nd.

20,837. "Improvements in electrostatic and other electrical measuring instruments." W. E. AYRTON, and T. MATHER. Dated November 3rd.

20,840. "Electric fire-damp indicator." A. E. SCHURR. (Communicated by J. Cauderay, Switzerland.) Dated November 3rd.

20,847. "Improvements in carbon brushes, blocks, or collectors for electric generators and motors." W. H. SCOTT. Dated November 3rd.

20,850. "A process by which by combined chemical and electrical action he obtains motive power." F. G. TREHAME. Dated November 3rd.

20,883. "Improvements in brackets or supports for insulators for telegraphic, telephonic, and other like purposes." BULLERS, LIMITED, and E. J. CHAMBERS. Dated November 3rd.

20,891. "Improvements in phonographs and telephones." P. A. NEWTON. (Communicated by A. Nobel, France.) Dated November 3rd.

20,896. "Apparatus for working semaphore signals by means of electric currents." SIEMENS BROTHERS & Co., LIMITED. (Communicated by Siemens & Halske, Germany.) Dated November 3rd.

20,915. "Improvements in alternate current synchronisers." W. E. AYRTON, and T. MATHER. Dated November 4th.

20,923. "Improvements in the means of charging and discharging primary electric batteries." H. T. BARNETT. Dated November 4th.

20,966. "Improved incandescent electric lamp." J. PLUMMER. Dated November 4th.

20,975. "Improvements in voltaic batteries." J. A. S. GREGG. Dated November 4th.

21,004. "A method of and apparatus for electrically protecting trains." K. RODLER. Dated November 4th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

3,887. "A system of sending and receiving fire or other special signals over telephone lines." F. E. STUART. Dated February 29th. In an ordinary telephone circuit between fire stations, with electric bells, the inventor places a second contact-maker at each end, and also a polarised relay, and local bell and indicator circuit; when the ordinary push is used, it calls attention to the telephone at the other end of the circuit, but when the second contact-maker or push is used, it reverses the relative positions of the poles of the battery on the line, and return wires or on the line and earth wires, and the current operates the polarised relay in the reverse direction, at the other end of the circuit, which polarised relay being reversed, connects a second and local circuit, which rings a different bell, and if necessary drops an indicator, thus indicating a fire or special call. 5 claims.

7,492. "Improvements in and connected with electric bells." H. OPPENHEIMER. Dated April 20th. The inventor punches from an iron sheet a piece in the form of the armature and being on its extension of a smaller shape. This latter portion of the stamping he drills and after this has been done he uses a draw claw bringing the thinner part between this twofold cutter and thus attaining the result of giving the stem flexibility. Also relates to a watertight cover. 2 claims.

7,826. "Improvements in electric lamp shades as a medium for advertising." T. FROGGATT. Dated April 26th. The inventor arranges the shade or lamp holder in such a manner that, the base or such part thereof as is fixed against the roof or other part of the vehicle, and to or upon which the incandescent lamp is attached, shall be flat or concave upon the side facing the lamp, and may be plain or faceted, and painted or glazed, or both, in some light tint, so as to form a reflector, upon which he purposes to emboss, paint, write or otherwise display, an advertisement or advertisements, so as to be seen and read at all times, but more particularly when the lamp is alight or incandescent. 3 claims.

8,211. "Improved means for stopping or controlling electrical railway and tramway engines or carriages." M. H. SMITH and T. P. WILSON. Dated April 30th. Consists in an arrangement of parts whereby such motor forms part of a closed circuit. With this arrangement if the switch be so set that if the current from the source of supply were on, the motor would be driving in reverse direction to the travel of the car, then as the car travels the current generated by the motor in the closed circuit will increase in proportion to the increased speed of the car and will almost immediately become sufficient to stop the motor temporarily and consequently the car or engine. 1 claim.

9,148. "Improvements in swing joints or ceiling connections for carrying suspended electric light fittings or combined electric light and gas fittings." P. G. EBBUTT and J. B. VERITY. Dated May 14th. The inventors provide a ball joint, the upper part of the cup of which is by preference perforated to allow of the wires being jointed after the fitting is fixed and then being hidden from view in the said swing joint. In order to prevent the said ball part of the joint to which the fitting is attached, being rotated through a complete circle and thereby twisting the wires, pegs or stops are provided. 3 claims.

9,536. "Improvements in systems of electric distribution." H. J. ALLISON. (Communicated from abroad by C. O. Mailloux, of New York.) Dated May 19th. Consists substantially in adding to subtracting from the drop or loss in one or more of the feed wires or conductors which supply the consumption circuits of the system, by using a supplemental electromotive force generator in the circuit of said feeder and adjusted and applied to produce with normal load an effect assisting or opposing the electromotive force of the main generator in proper degree to give a resultant drop on said feeder such as is required to secure the desired relation of potentials or pressure on the different consumption circuits or portions of consumption circuits. 14 claims.

9,850. "Improvements in fans operated by electricity." J. H. PICKUP, J. BYROM, and J. ASHWORTH. Dated May 24th. According to this invention the field magnets are constituted by a ring which has pole pieces extending as lips for a considerable distance around the armature which is contained within the said field magnets. The said armature is also of ring form so as to leave a large passage for air through it. The armature is mounted upon a shaft the bearings of which may be carried by a framing connected to the ring carrying the field magnets, or by a framing otherwise supported. The blades of the fan are connected to the shaft at some distance from the armature, and either inside or outside the framing. 1 claim.

10,388. "Improvements in secondary batteries." E. FREUND and L. BRISTOL. Dated May 31st. The positive and negative plates in each cell are slightly inclined towards each other, the top edges being further apart than the bottom edges. Between the plates are inserted a series of tapered staves, having the same degree of taper as the space between the plates, their distances apart being preferably about equal to the distance between the plates. 10 claims.

10,430. "An improvement in electrical insulating sheet." R. WOOD. (Communicated from abroad by C. W. Jefferson, and R. R. St. John, both of New York.) Dated June 1st. Consists in a so-called mica sheet formed of small irregular sheets and layers of thin mica fastened flatly together by means of a suitable adhesive material, such as French varnish, and faced on one or both sides, or in between the intervening layers of mica, with a thin fibrous material. 5 claims.

10,524. "Electrical insulating sheet." A. H. S. DYER. Dated June 2nd. The inventor takes a sheet of iron and coats it with a varnish suitable for the purpose and places upon said plate smaller, irregular pieces in such a relation to each other as to cause the edges to overlap. Upon this layer of small and very thin pieces of mica he places another layer with a coating of varnish intervening, and he proceeds in this manner until a plate of approximately the required thickness is formed. He then heats the plate in an oven, or by means of steam, and while the solvent of the varnish is being evaporated, he rolls the plate so as to discharge the surplus varnish, leaving only enough between the layers to cement them together. He then subjects the plate while it is still warm to very heavy pressure by means of a hydraulic press. 7 claims.

11,087. "Improvements in galvanic batteries." W. L. WISE. (A communication from T. Rosati, E. Righetti, and G. O'Connell, of Florence.) Dated June 13th. Has reference to a construction of galvanic cell comprising a plate or cylinder of lead, and a plate or cylinder of carbon, or it may be of a metal that acts positively with regard to lead, these two plates or cylinders being immersed in water acidulated with a mixture of nitric and sulphuric acids, or with another similar mixture. 1 claim.